ILLINOIS
COAL MINING INVESTIGATIONS
COOPERATIVE AGREEMENT

State Geological Survey
Department of Mining Engineering, University of Illinois
U. S. Bureau of Mines

BULLETIN 10

Coal Resources
OF
District I (Longwall)

BY

GILBERT H. CADY

Field Work by G. H. Cady, K. D. White, and others

In cooperation with
U. S. Geological Survey

STATE GEOLOGICAL SURVEY
UNIVERSITY OF ILLINOIS
URBANA
1915

The Forty-seventh General Assembly of the State of Illinois, with a view of conserving the lives of the mine workers and the mineral resources of the State, authorized an investigation of the coal resources and mining practices of Illinois by the Department of Mining Engineering of the University of Illinois and the State Geological Survey in cooperation with the United States Bureau of Mines. A cooperative agreement was approved by the Secretary of the Interior and by representatives of the State of Illinois.

The direction of this investigation is vested in the Director of the United States Bureau of Mines, the Director of the State Geological Survey, and the Head of the Department of Mining Engineering, University of Illinois, who jointly determine the methods to be employed in the conduct of the work and exercise general editorial supervision over the publication of the results, but each party to the agreement directs the work of its agents in carrying on the investigation thus mutually agreed on.

The reports of the investigation are issued in the form of bulletins, either by the State Geological Survey, the Department of Mining Engineering, University of Illinois, or the United States Bureau of Mines. For copies of the bulletins issued by the State and for information about the work, address Coal Mining Investigations, University of Illinois, Urbana, Ill. For bulletins issued by the United States Bureau of Mines, address Director, United States Bureau of Mines, Washington, D. C.

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COAL RESOURCES OF THE LONGWALL DISTRICT OF NORTHERN ILLINOIS (DISTRICT 1)

By Gilbert H. Cady

CHAPTER I—INTRODUCTION

IMPORTANCE OF THE AREA

The amount of fuel originally available in the 1700 square miles of the Longwall District (Fig. 1 and Plate I) is enormous, being approximately 5,977,000,000 tons. Of this amount only about 3 per cent has been mined or placed beyond recovery by past mining. At the present rate of production (1913) this available coal would supply the State for about 90 years. The additional value of the millions of yards of shale and clay and cement-making limestone associated with the coal, and the location of the area near the Chicago market gives this district an economic importance second to none of the districts of the State. The mineral products obtained from the coal-bearing rocks of the area had a total value in 1912 of about eight and one-half million dollars, or about 7 per cent of the total value of the mineral products of the State for that year, although the district comprises only 3 per cent of the total area of the State. The estimate does not include the output of several zinc smelters and rolling mills and glass factories attracted to the region by the accessibility of the fuel, the value of whose manufactured products is several million dollars annually. It seems improbable that another area of the State of similar size outside of the oil fields produces from its own natural resources products having a greater value.

ACKNOWLEDGMENTS

This description of the coal resources of the Longwall District is one of a series of reports on the Illinois coal districts being prepared under the cooperative agreement of the State Geological Survey with the Department of Mining Engineering of the University of Illinois and the U. S. Bureau of Mines. The reports on coal resources cover

approximately the same areas as corresponding bulletins on Coal Mining Practice, as defined in Bulletin 1: *"A Preliminary Report on Organization and Method of Investigations."*

In the study of this region little special field work has been undertaken by the writer, but use has been made of the excellent notes taken in 1912 by Mr. K. D. White in the mines selected for field observation under the cooperative agreement. It has been the purpose to assemble also the information previously collected by other members of the Survey since its organization. Field notes by the following men have been reviewed: Messrs. Jon A. Udden, Frank F. Grout, E. W. Shaw (U. S. Geological Survey), L. W. Swett, Edwin F. Lines, E. H. Pool, and O. F. Brooks. Much of the information collected in cooperation with the U. S. Geological Survey by Professor U. S. Grant and the present writer in the study of the La Salle and Hennepin quadrangles has been incorporated in this report. The results of drilling operations conducted under the direction of Mr. G. S. Rice, now Chief Mining Engineer of the Bureau of Mines, have contributed much to our knowledge of the stratigraphy and structure of the district.

To the kindly cooperation of the various mining companies in this field, the Survey is indebted for the large amount of information. There has been a generous response to requests for drilling records and other information of a geological nature, even though much was of a confidential character. Individual mention would hardly stop short of a complete list of the companies. From the superintendents of the various mines, from the pit bosses, and not infrequently from the miners, have come many of the details of our information.

In the preparation of the report the writer is especially indebted to the Director, Mr. Frank W. DeWolf, and to Mr. F. H. Kay for kindly and helpful suggestions, and to Miss Helen Skewes, Messrs. M. L. Nebel, and L. S. Baldwin for aid in the preparation of the various diagrams and sketches.

DEFINITION AND EXTENT OF THE LONGWALL DISTRICT

The Longwall District is so called from the prevailing method of mining. The western part of the field is commonly spoken of as the "third-vein" field, because the principal coal mined at La Salle is the third bed below the surface. In the eastern part of the field this bed is known as the Wilmington coal. This "third vein" or "Wilmington" bed is coal No. 2 of the Illinois section, and is recognized by the State and U. S. Geological Surveys as approximately equivalent in age to the Murphysboro coal of southwestern Illinois. By definition it marks the base of the Carbondale formation of the Pennsylvanian system in this State.

The Longwall District includes the area underlain by coal No. 2 in commercial thickness. The area is limited on the north and east by the outcrop of the coal. On the south and west the coal probably continues beyond the limits of the area but in most places is not mined because of either its decrease in thickness or its greater depth in contrast to higher coals. To the south and west, therefore, the Longwall District merges with indefinite boundaries into the adjacent coal districts.

The accompanying map (fig. 1) shows the boundaries of the Longwall District as assumed in this report. Parts or all of the following counties are included in the area: Bureau, La Salle, Grundy, Will, Putnam, Marshall, Livingston, and Kankakee.

DEVELOPMENT OF MINERAL INDUSTRIES

This area lies near Chicago and is therefore crossed by many trunk lines, the more important of which are the Chicago, Burlington and Quincy Railway; the Chicago, Rock Island and Pacific Railway; the Atchison, Topeka and Santa Fe Railway; the Chicago and Alton Railroad; the Illinois Central Railroad; the Chicago, Indiana and Southern Railroad; and the Wabash Railroad. The transportation facilities are apparently ideal, but the present depression in the mining business of the district is thought by coal operators to be due to an artificial discrimination in freight rates between this and other districts of the State.

There are a number of important small cities in the district, the chief of these being Streator, La Salle, Peru, and Ottawa. These, and several of the smaller towns, Spring Valley, Granville, Oglesby, Coal City, South Wilmington, and Morris, owe much of their importance to the development of the mineral resources of the vicinity. The district contains rich and largely undeveloped resources of shale, clay, coal, glass sand, and limestone for cement making and for other uses. With slightly more favorable mining and transportation rates, and with useful canals traversing the district, the field might hold its own with any in the State. The coal output of the State has gradually advanced from north to south. In 1881 La Salle County led in output with 624,900 tons; in the next year it still held first place with over 2,000,000, after which the center of production moved south until the county leading in 1907 and 1908 is at the extreme southern end of the coal field. The center of production has steadily receded from Chicago markets because of (1) development of north-south railroads; (2) proportionately cheaper ton-mile rates; (3) thick coal and other conditions favoring easy mining; (4) low tonnage price paid to miners; (5) better quality of coal in the southern counties. It is thought by

some that the eventual revival of coal mining in the area will depend on the use of coal at the mine to develop power, coal-gas products, and coke, so as to free the producer from much of the burden of transportation.

No oil or important gas fields have been discovered in the district, but the possibilities do not seem to have been exhausted, especially along the line of the La Salle anticline.

CHAPTER II—GENERAL GEOLOGY

INTERPRETATION BY MEANS OF BLOCK DRAWING

In order to understand the position of the coal beds in the geological formations present in the district, a knowledge of the general geological relations is necessary. In the following description of the general geology the rocks older than the "Coal Measures" or coal-bearing rocks are discussed very briefly, whereas the "Coal Measures" are considered in great detail. Operators or engineers in charge of development work will, it is hoped, find this a valuable reference chapter. The reader may, however, prefer to turn to other chapters directly and may refer to the Contents for topics of greater interest. The general relationship of the coal to the other strata is shown by the accompanying block diagram or stereogram (Pl. II). The drawing is diagrammatic and does not conform closely to horizontal scale or geographic boundaries.

The diagram represents a block of the earth's crust about as it is in the Longwall District. The block is divided into three sections along east-west lines. From the south section nearest the reader, all the strata have been removed to the base of the "Coal Measures" or Pennsylvanian series. The resulting surface represents that upon which the Pennsylvanian rocks were laid down, and is seen to be underlain by various kinds of rocks dipping eastward away from the fold, which trends approximately northwest-southwest. The fold is known as the La Salle anticline. It is shown to vary both in closeness and in height. To the south it is more gentle than to the north. Increasingly younger rocks next underlie the "Coal Measures" toward the east and toward the west from the axis of the fold as is shown in the diagram, and because of the unsymmetrical character of the anticline, which is much steeper to the west than to the east, the formations succeed one another much more rapidly to the west than to the east. In addition to the eastward and westward dip of the older strata there is also a dip toward the south, so that younger rocks are more likely to lie under the Pennsylvanian system to the south than to the north.

The middle section of the diagram (Pl. II) shows the surface of coal No. 2 as it would appear if all the overlying rocks were removed. It differs from the original surface of the coal in being folded along the axis of the anticline and in being limited on the east by an erosional, rather than a depositional, edge. The coal bed as originally

formed probably had a very level surface and a gradually diminishing thickness toward the edges.

After the accumulation of the coaly material the deposition of other Pennsylvanian strata continued to a thickness of at least 500 feet above coal No. 2 in the center of the district. That this thickness persisted over all the area seems improbable. The succession evidently was thinner east of the anticline and toward the old shore line, which probably lay several miles beyond the present line of outcrop of the "Coal Measures."

At some time after the deposition of coal No. 2, and possibly after the close of Pennsylvanian deposition in this area, further movement along the line of the anticline occurred so as to fold the coal and other rocks as shown in the diagram. An earlier period of movement is described under "Structure."

The long period or periods of erosion that followed the deposition of Pennsylvanian strata removed the "Coal Measures" entirely from some areas and greatly thinned them in others. Just before the glacial period valleys had been cut so as to expose the coal, and the outcrops on the north and east were eroded back irregularly toward the center of the coal field. The boundaries of the coal could be readily traced if the covering of glacial drift were removed. The glacial material left by the ice is of general occurrence except where it has been removed by subsequent erosion, and is of irregular thickness, reaching a maximum of 340 feet. It is represented in the north section of the diagram in Plate II. The surface is in general a plain, but is cut here and there by steep-sided valleys which may or may not penetrate the underlying rock. The drift surface evidently bears no relation to the underlying rock surface, and therefore the limits of the coal beds can be determined only by extensive drilling.

This brief explanation of the stereogram (Pl. II) presents the three main groups of strata within the Longwall District and shows the general relationship existing among them. These strata in ascending order are (1) the pre-Pennsylvanian rocks ranging in age up through the Devonian and separated from the overlying rocks by an erosion unconformity that is conspicuous in parts of the district; (2) the Pennsylvanian rocks, consisting of sandstone, shales, limestones, and the thin beds of coal which are the special objects of our attention; and (3) the glacial drift. The main structural feature is a general southward dip interrupted by the pitching fold of the La Salle anticline which trends about northwest-southeast. Each of the groups of strata receives more detailed description in the pages that follow, and the structural features will be discussed at some length. There is also presented in Plate III a stereogram of the Longwall Dis-

trict showing the main geographic and geological features, to accompany the description of the geology.

STRATA BELOW THE "COAL MEASURES"

(PRE-PENNSYLVANIAN ROCKS)

The strata next underlying and forming the floor for the "Coal Measures" of the Longwall District as shown by Plate III range in age from the St. Peter sandstone to Devonian limestone and shale. The age of the underlying rock at Wenona, however, is unknown; it may possibly be as young as Mississippian. The Lower Magnesian limestone is the oldest rock exposed at the surface within the State. Possibly in a few places in the vicinity of La Salle it originally lay next below the Pennsylvanian or, at any rate, was separated from the Pennsylvanian by only a few feet of the St. Peter sandstone. The Lower Magnesian limestone is exposed along the Illinois River bluff between Utica and La Salle, along Pecumsaugan Creek, and along Tomahawk Creek and Little Vermilion River three and four miles north of La Salle. Where it outcrops along the streams, it forms perpendicular cliffs which reach a height of 50 to 75 feet. Figure 2

FIG. 2. The Lower Magnesian limestone outcropping along the north bluff of Illinois River between Split Rock and Utica (photo by T. E. Savage).

FIG. 3. Lower Falls in Deer Creek Glen; a canyon in St. Peter sandstone (photo by Rhodes).

shows the character of the Lower Magnesian limestone between La Salle and Utica.

The St. Peter sandstone underlies the Pennsylvanian system extensively, particularly along the anticline on the two Vermilion rivers and along, and north of, Illinois River east of the anticline as far as a

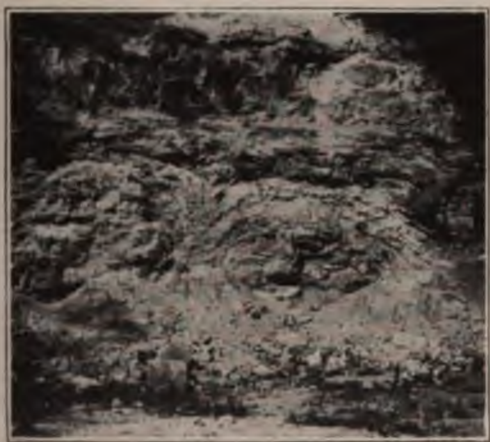

FIG. 4. The contact of St. Peter sandstone and Lower Magnesian limestone near Split Rock. (Vertical scale about 16 ft. to 1 inch)

point halfway between Marseilles and Seneca. The bluffs of Illinois Valley are largely St. Peter sandstone from Utica to Twin Bluffs on the north side of the river, and from the anticline to the mouth of Covel Creek on the south side of the river. In this rock the beautiful gorges of Starved Rock and Deer Park have been carved (see figure 3). The St. Peter sandstone is variable in thickness, largely because of the irregular surface of the Lower Magnesian limestone upon which it was deposited. Figure 4 is a photograph taken near Split Rock and shows the St. Peter sandstone resting on the uneven surface of the Lower Magnesian limestone. The sandstone varies from about 120 to 200 feet in thickness in this district. It is an important source of glass sand and also supplies some of the artesian water.

The formation overlying the St. Peter sandstone is the Platteville limestone commonly known as the Trenton limestone. This formation passes upward without conspicuous interruption into the Galena dolomite. These two formations are practically inseparable as found in this district, especially on the basis of information obtained from drill records, hence they will be described collectively as the Galena-Platteville or Galena-Trenton formation. This extends from Deer Park northward as a narrow belt along the west side of the fold under

the Pennsylvanian strata. Southward from Deer Park the limestone seems to be present over the fold and to extend eastward for 12 or 15 miles.

The stereogram on Plate III shows in a generalized way the relation of the Galena-Trenton to the anticline and to the overlying Maquoketa shale. The east boundary between the limestone and the shale passes southeastward from about midway between Seneca and Morris toward Ransom in southeastern La Salle County. The Galena-Trenton is exposed along the west side of the anticline at various points on Vermilion River as far south as Lowell, at Split Rock, and along Little Vermilion River about four miles north of La Salle. East of the fold the limestone is found as a thin layer above the St. Peter sandstone and below the Pennsylvanian fire clay at various places as far as Ottawa. The Galena-Trenton averages 250 to 300 feet thick within this district.

The Maquoketa shale is present to the west of the Galena formation as a narrow belt on the west side of the anticline. On the east side of the fold it underlies the "Coal Measures" throughout most of Grundy County. In the southeastern part of Grundy, and in the neighboring parts of Livingston, Kankakee, and Will counties, the Niagaran limestone lies between the Maquoketa shale and the Pennsylvanian system. The Maquoketa is exposed along the east border of the Longwall District on the Kankakee, Dupage, and Desplaines rivers; within the district, however, it is known only from drill samples obtained from artesian wells. It has a variable thickness within the district up to about 200 feet.

The Niagaran limestone, which outcrops extensively in the vicinity of Joliet, is known within the borders of this area only from drill samples. There is evidently a considerable area in the southeast corner of the district east and south from Dwight, where the Pennsylvanian overlies Niagaran dolomite. West of the anticline, and apparently beyond the zone affected by the folding, the Niagaran is present and increases in thickness to about 400 feet in the vicinity of Depue. (See record in Chapter IV.)

The Devonian formation underlies the Pennsylvanian rocks in a small area in the Longwall District, but is not known to outcrop nearer than in the vicinity of Rock Island, Illinois. Within this area reddish Devonian shales containing *Sporangites* have been identified by Professor J. A. Udden in samples from the well at Henry, but the extent of this area of Devonian is uncertain. Devonian formations are not known below the Pennsylvanian system on the east side of the anticline.

The stereogram of the Longwall District (Plate III) shows

the rocks from the surface down to sea level. This diagram and that shown in Plate II explain graphically the various relations that exist between the Pennsylvanian system and the underlying rocks in this district. The larger stereogram is drawn to scale, and the geology is represented as accurately as is consistent.

PENNSYLVANIAN SERIES OR "COAL MEASURES"

General Description

The general succession of the Pennsylvanian series in the central part of the Longwall District where conditions are most typical is excellently recorded in the detailed section by H. C. Freeman.[1] This section, with some modifications suggested by recent investigations, is reproduced in Chapter IV. Most of the drilling shown on the map, Plate I, has been done since Mr. Freeman's work, so that a more accurate knowledge of the geological conditions is now possible, and it is necessary to modify the original section in some particulars and to suggest correlations not evident to the earlier investigator.

The Illinois "Coal Measures" are divided into three formations, all of which are represented in the Longwall District. In ascending order these are the Pottsville formation, the Carbondale formation, and the McLeansboro formation. In southern Illinois, where the section is more complete and thicker, these formations are more characteristically developed, and the horizons of separation are definite. The Pottsville includes that part of the Pennsylvanian series which lies below coal No. 2, the Carbondale is represented by the portion between the base of coal No. 2 and the top of coal No. 6, and the McLeansboro formation includes all the "Coal Measures" lying above coal No. 6.

In this district the Pottsville is distinct as elsewhere and lies below coal No. 2. The boundary between the Carbondale and the McLeansboro is not so clear. Coal No. 6 is apparently not represented in the district, unless it be in the vicinity of Sparland, and it seems that the division between the two formations is at a probable unconformity between coal No. 5 and coal No. 7. The formation above this possible unconformity comprises the thickest part of the Pennsylvanian series in the northern district, and it can probably be subdivided on good stratigraphic grounds.

The Longwall District is divisible into a number of subdistricts or fields, in each of which the details of stratigraphy are fairly constant. The correlation of the sections of the various fields, however,

[1] Freeman, H. C., La Salle County: Geology of Illinois, Ill. Geol. Sur. 1867, pp. 264 to 266.

seems possible only in a general way, although certain major parts of the local sections seem to agree with certain parts of other local sections, yet the attempt to correlate smaller units, such as local beds of sand, clay, limestone, coal, or shale seems inadvisable. There are, however, some exceptional strata, including some coal beds, which are widespread and are readily identifiable from place to place.

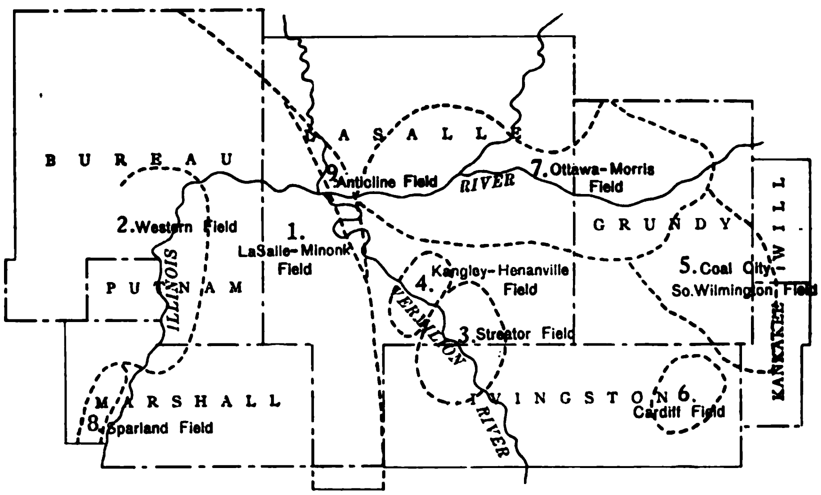

FIG. 5. Sketch map showing location of subdistricts.

The fields (see figure 5) into which the Longwall District is divisible are as follows:

(1) The La Salle, Bureau, and Putnam counties field west of the anticline and east of the bend in the Illinois: the La Salle-Minonk field.

(2) A small area in the vicinity of Bureau, Bureau County, running south possibly 10 to 12 miles and extending indefinitely westward: the Western field.

(3) The Streator field east of the anticline.

(4) The Kangley-Henanville field, a small area lying north and northwest of Streator field along Vermilion River.

(5) The Coal City-South Wilmington field.

(6) The Cardiff field.

(7) The Illinois River field from the anticline to Morris: the Ottawa-Morris field.

(8) The Sparland field.

(9) The axis of the anticline along Little and Big Vermilion rivers: the Anticline field.

Pottsville Formation

LA SALLE-MINONK FIELD

The variations in the character of the Pottsville formation among the different fields of the Longwall District are considerable. In the La Salle-Minonk field for three or four miles west of the anticline the Pottsville is unusually thick, some drillings in the vicinity of La Salle showing 200 to 275 feet of siliceous shales and sandstone. The record of the well of the Chicago Portland Cement Co. at Oglesby given in Chapter IV and reproduced on Plate IV (No. 6) is representative of this thick phase of the Pottsville. The position of this unusual thickness of Pottsville is shown in the stereogram, Plate III, in the vicinity of La Salle and Peru. The formation is shown to be thinner westward from Spring Valley to Depue. At this latter place the Devonian (?) limestone lies relatively close to the base of coal No. 2 as is shown in the record of well No. 2 of the Mineral Point Zinc Co., given in Chapter IV. Westward from Depue the underlying rock surface declines, coal No. 2 rises somewhat, and the intervening Pottsville accordingly becomes thicker.

WESTERN FIELD

The Pottsville in the small western field near Bureau is about 80 feet thick. Coal No. 2, if correctly identified in this small area, varies from about 2 feet to about 3 feet in thickness. A coal 2 feet or less in thickness is recorded in several of the logs 30 to 40 feet below coal No. 2. Some of the records also note another 1-foot bed of coal 25 to 30 feet lower in the section, and still another of about the same thickness 10 to 15 feet below. The intervening strata are blue or gray shales which in places are siliceous. One log shows a thin limestone about midway in the section. The Pottsville in the vicinity of Bureau rests on limestone, probably of Niagaran age. A record of drilling in this field is given in Chapter IV, and is also shown on Plate IV (No. 11).

Southward towards Putnam and Marshall counties along the Illinois Valley the Pottsville continues thick. Observations of drill records show at least 100 to 110 feet of sediment below coal No. 2. The formation contains one thin bed of coal near the bottom, and a sandstone about 25 feet thick near the middle of the section. In this region, at least in the vicinity of Henry, the Pottsville seems to rest upon Devonian shale. The record of strata below coal No. 2 encountered in a drill hole in T. 30 N., R. 2 W., located opposite Henry, is given in Chapter IV and is log No. 12, Plate IV.

OTTAWA-MORRIS FIELD

East of the anticline along Illinois River from the anticline to

Morris the Pottsville is in very few places over 25 feet thick. North of the river toward the outcrop it becomes still thinner and to the south, thicker. From the anticline eastward to Morris the formation is practically all fire clay, which varies in character accordingly as the underlying rock is sandstone, limestone, or shale.

ANTICLINE FIELD

In that part of the district lying along the anticline and Vermilion rivers (Anticline field), the clay is in many places separated into two

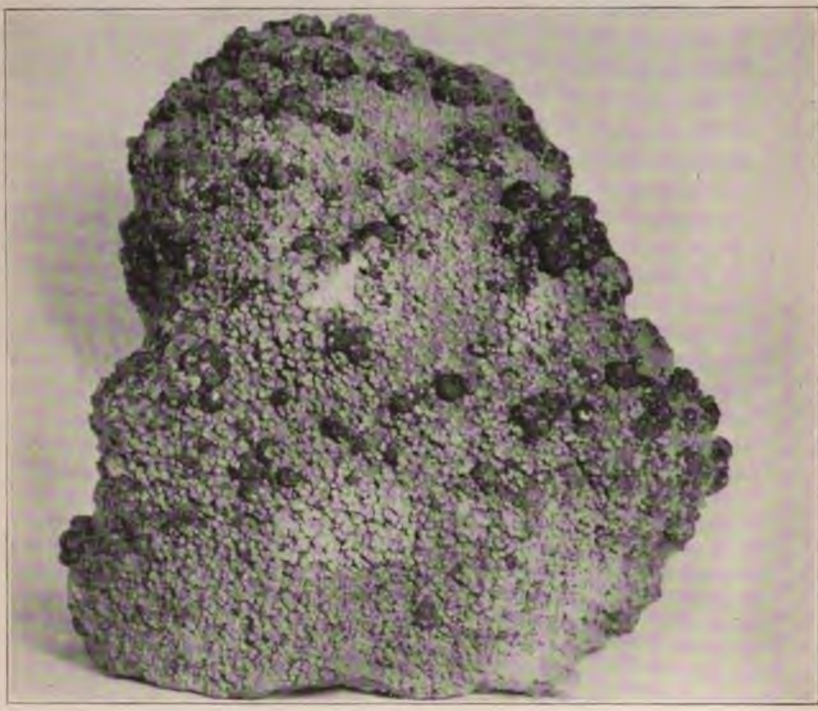

FIG. 6. Boulder of pisolitic limestone from the Pottsville formation of southwestern Illinois.

beds by a sandstone varying from 1 to 5 feet in thickness. Along Little Vermilion River the sandstone is thicker than the underlying clay except locally, whereas along Vermilion River this lower clay is of greater thickness and the sandstone plays out to the south. Above the sandstone in clay pits in the vicinity of Deer Park are found round boulders of limestone of a peculiar pisolitic structure, which upon weathering break up into small, round fragments about one-fourth inch in diameter. Most of the broken surfaces display a cross-section of

each nodule and show a radiating structure. The rock therefore is easily identified. Figure 6 shows a boulder of pisolitic limestone from the same horizon in the southwestern part of the State, but similar to those found in this district. This limestone is thought to correspond to a similar bed above the Cheltenham clay at St. Louis.

In the Longwall District the pisolitic limestone has been seen in the clay mine of the Illinois Clay Products Co. at Deer Park, in the exposures on the north side of Vermilion River at Lowell, and along one of the gullies running through the west side of Starved Rock Park from the south. Although the limestone or the sandstone is not everywhere present in this clay, it nevertheless seems probable that over much of the area east of the anticline the Pottsville is represented by two clays, the lower one of which is not in every place easily distinguishable from the upper, but which probably represents an earlier period of deposition.

STREATOR AND SOUTHEASTERN FIELDS

In the Streator field the Pottsville has the same general characteristics as it has along the Illinois to Vermilion River. The formation is at least 20 to 30 feet thick and is composed of gray clays and sandstone. The details of the succession are not known. In the Wilmington and Coal City and the Cardiff fields the Pottsville is thicker than elsewhere east of the anticline. At Cardiff 40 feet of Pottsville are present The formation is composed of one or two thin coal beds, shales, and thin limestone and sandstones. The details of stratigraphy are known from only one or two records so that generalization is impossible.

THE CARBONDALE FORMATION

The Carbondale formation lying next above the Pottsville can be described best by considering separately the stratigraphy of certain subdistricts.

THE WESTERN FIELD

As has been pointed out in the discussions of the Pottsville certain irregularities in the "Coal Measures" in the area lying west of Depue and Granville and south of T. 16 N., make difficult the definite correlations of the coal. In the first place, throughout this area the two upper coals have been eroded and the outcrops are deeply covered by glacial drift, so they are of no aid in correlation. Secondly, the structure is uncertain, although there seems to be a rather sharp rise of the strata to the west, as is indicated on the structure contour map, Plate I. Again, several thin coal beds in the section have about the same thickness, so that the identification of No. 2 is uncertain. Finally, all our information is based upon about 10 drill records, there being no surface data whatever.

The strata of the Carbondale in this field are known only for about 100 feet above the base of the formation, the upper part having been removed by pre-glacial erosion. Of this 100 feet of strata, all but a small proportion is shale, blue, gray, and black. In several of the records a thin limestone is noted 50 to 60 feet above coal No. 2. In the lower 20 feet of the formation is a black shale which probably corresponds to the fissile shale in most places present at this horizon over large areas of the Longwall District.

LA SALLE-MINONK FIELD

Lying west of the anticline and stretching from the northern to the southern limits of the district is an area where the succession as presented by Freeman[2] in his discussion of the Geology of La Salle County seems to hold. Toward the south there are probably some changes involving the introduction of coal No. 6 and the possible elimination of coal No. 7, which have not yet been determined.

Coal No. 2 is persistent and is everywhere apparently of workable thickness, averaging 42 inches. It can be readily correlated in the different drill records. The coal will be described in detail on a later page (see Chapter IV). As a rule coal No. 2 is overlain by a gray shale or "soapstone", 12 to 18 feet thick. In places this shale is absent entirely, and the next overlying stratum rests upon the coal. Above the "soapstone" there follows a 3-foot bed of black, fissile shale, which contains in many places large nodules of black ironstone. Concretions of a somewhat different character are found for a distance of about 4 feet in an overlying gray shale. The latter nodules possess a peculiar structure due to planes of calcite passing through them, have a weathered surface that resembles the shell of a turtle, and break in a very characteristic manner. So far as known, this is the only horizon in the Carbondale of this district where such *septarian* concretions are found, and they afford a rough, but apparently reliable, means of identification of the underlying black shale. Above the septarian bed is 8 to 10 feet of grayish-blue, rather plastic shale or clay capped by a calcareous sandstone, 2 to 5 feet thick. Above the sandstone follows another black shale which in places is almost a cannel coal. This black shale differs from the black, fissile shale below in the fact that it is not so sheety, but tends to break into rectangular fragments. These are readily identifiable along the streams where they have been washed out, as along Vermilion River near Lowell. This carbonaceous bed is about 4 feet thick and is locally overlain by a thin, impure limestone. Commonly overlying the limestone is gray shale becoming more or less siliceous toward the top. This shale varies in

[2] Op. cit.

thickness to a maximum of possibly 75 feet. Along Vermilion River it does not exceed 20 feet. There follows a heavy sandstone also of variable thickness. In some places it occupies the entire horizon of the underlying siliceous shale and attains a thickness of 60 to 75 feet or more, but in other places is entirely replaced by the shale. Where the sandstone is thickest the middle bed of coal, thought to be No. 5, is absent. The sandstone is evidently in all places younger than the shale, since it seems to lie in troughs cut into the shale, and there is an abrupt change from one rock to the other. Although this is prob-

FIG. 7. The heavy sandstone below coal No. 5 (Vermilionville sandstone) outcropping along the big bend in Vermilion River between Deer Park and Lowell.

ably not sufficient evidence for believing that an erosion plane exists between these two terranes, their relationships are certainly suggestive of rapid changes in conditions of deposition. This sandstone will be called the Vermilionville sandstone in this report. Figure 7 shows this sandstone outcropping along Vermilion River between Deer Park and Lowell.

The accumulation of the peat which represents coal No. 5 seems to have taken place during an interruption in the deposition of the sandstone and sandy shale in more or less restricted areas, for of all the important coal beds in the district this is the most irregular in distribution. Coal No. 5, its underclay, and its overlying black and gray shale roof together comprise possibly 25 feet of the Carbondale section in this field. It is followed above by sandy shale and sandstone, which continues to the underclay of coal No. 7, a distance of 35 to possibly 75 feet.

The exact position of the top of the Carbondale formation in this section is not known. Where coal No. 5 is present it is certainly above that coal. Where the coal is not present the top of the formation must be regarded as indefinite. It seems probable that there were oscillations in sea level in this district during the time of the deposition of the siliceous strata associated with coal No. 5 which were about contemporaneous with similar changes in level noted by Savage[3] as existing in southern Illinois after the deposition of coal No. 6. In this region these changes were of such a nature as to give rise to several local planes of erosion. The coarse sandstones tended to be localized along the channels, to assume a lenticular cross-section as a result, and in place to cut down through and displace the coal. A continuous section of sandstone and sandy shale across the horizon of coal No. 5, such as occurs in a broad belt running north and south through the east side of Putnam County and the western edge of La Salle County, probably exists along one of these erosion lines. In such sections the top of the Carbondale may be as far below coal No. 7 as the usual interval between that and the No. 5 seam.

THE STREATOR FIELD

The Streator field lies east of the anticline in the vicinity of Streator. The Carbondale section is exposed in part down Vermilion River from Streator to sec. 32, T. 32 N., R. 3 E., and is known from mines and from shaft and drill records. The section of the Carbondale in this field differs from that of the La Salle-Minonk field, in that it is considerably thinner, and has a number of thin local beds of coal in the lower part of the section which possibly correspond to some of the black shales noted in the La Salle section.

There is sufficient evidence that the "Coal Measures" section as it rises over the anticline and extends eastward becomes notably thinner. West of the fold about 150 feet of strata lie between coals No. 2 and No. 5. In the exposures showing the succession between these two strata along Vermilion River near Deer Park, the interval between the two coals is about 100 feet. In the vicinity of Streator coal No. 5 is not present, but the interval between coals No. 2 and No. 7 is only about 150 feet, or 50 feet less than it is in the La Salle field.

It is impossible to present the lower part of the Carbondale section of this field with as great detail as for the La Salle-Minonk area because our information on this part of the section depends upon a few, rather unsatisfactorily drill records. In sinking the shaft of mine No.

[3]Shaw and Savage, U. S. Geol. Survey Geol. Atlas Murphysboro-Herrin folio (No. 185) p. 11, 1912.

2 of the Chicago, Wilmington, and Vermilion Coal Co., from coal No. 7 to coal No. 2 the following strata were penetrated:

Partial Log of Shaft No. 2,
Chicago, Wilmington and Vermilion Coal Co., Streator

	Description of Strata	Thickness		Depth	
		Ft.	*In.*	*Ft.*	*In.*
26	Coal No. 7				
25	"Slate"	2		2	
24	Fire clay	2	6	4	6
23	Sandstone	6		10	6
22	Slate	1	o	12	
21	"Soapstone"	6		18	
20	Sandstone	2	6	20	6
19	Coal		3	20	9
18	"Slate"	12		32	9
17	Sandstone	25		57	9
16	Blue granite (?) Niggerhead	2	9	60	6
15	"Soapstone"	3		63	6
14	Flinty "soapstone"	5	6	69	
13	"Slate"	4		73	
12	Sandstone	3		76	
11	"Slate"	1	6	77	6
10	Coal	2	6	80	
9	Fire clay	3		83	
8	Sandstone	3		86	
7	Blue limestone	3		89	
6	"Soapstone" and boulders	15	6	104	6
5	Coal	2	4	106	10
4	Blue shale	14		125	10
3	"Slate"	5		125	10
2	"Soapstone"	21		146	10
1	Coal No. 2	4		150	10

In this record it seems probable that the lower four members are essentially the same as the strata in the La Salle region below the septarian shale. Coal No. 5 of the above section is possibly the equivalent of the cannel coal which lies a few feet above the septarian bed. Other parts of the section, however, cannot be identified until the heavy sandstone No. 17 of the section is reached. No. 10 does not seem to be the equivalent of any persistent bed in the La Salle field. The sandstone, No. 17, is thought to belong to the series of sandstones and shales which is associated with coal No. 5 horizon, and which outcrops in cliffs 50 to 75 feet high along Vermilion River between Lowell and Streator. As elsewhere in the Longwall District, this sandstone is of variable thickness in the Streator field. In places it lies next below coal No. 7 in great thickness, and elsewhere it is separated from coal No. 7

by a succession of shales which may contain beds of coal. The stratigraphic succession in the Kangley-Henanville field is of this latter character, which serves to separate it somewhat from the Streator field as a whole.

The correlation of formations of the Streator and the La Salle fields is based largely upon the possibility of tracing coal No. 2 with little interruption from one field to the other by the way of Vermilion River. The coal horizon goes under the river not far above Lowell. It has been found about 30 feet below the river 4 miles above the Lowell bridge in sec. 24, T. 32 N., R. 2 E., and two miles farther up stream at about the same depth. At Streator the coal is about 400 feet above sea level, or about the same elevation as at Marseilles.

The section exposed along Vermilion River south of Lowell is unfortunately not continuous, so that the upper strata cannot be traced from one field to another. In secs. 24 and 25, T. 32 N., R. 2 E. and sec. 30, T. 32. N., R. 3 E., the bluffs above Vermilion River are composed entirely of glacial drift. The essentially horizontal position of coal No. 2 through the area, as described in the preceding paragraph, makes it reasonable to suppose that the overlying rocks were horizontal before they were eroded, and that correlations across the break are fairly safe. In sec. 32, T. 32 N., R. 3 E., and secs. 5, 8, and 9, T. 31 N., R. 3 E., the river is lined on one side or the other by a practically con-

Coal –

Fig. 8. Coal No. 7 and the underlying sandstone near the Kangley Bridge on Vermilion River.

tinuous cliff of sandstone. Below the sandstone is a blocky, black, fissile shale and cannel coal, which is possibly equivalent to the black, fissile shale lying 35 to 40 feet above coal No. 2 north of Lowell and along Vermilion River.

About one-fourth mile west of the Kangley Bridge over Vermilion River the surface of the heavy sandstone declines, and the Streator, or No. 7, coal, is found a few feet above the river at the level of the middle of the sandstone if it were continuous. Upstream, east of the bridge, this coal bed rises to an elevation of possibly 35 to 40 feet above the water. Below the coal for about 20 feet are clays and shales, the latter containing a black, carbonaceous stratum and streaks of coal. Below this lies the sandstone about 5 feet thick. Figure 8 shows the coal and sandstone east of the Kangley bridge. The sandstone thickens considerably again upstream, so that from where the river bends south along the north line of sec. 15, T. 31 N., R. 4 E. to the Chicago, Indiana and Southern Railroad bridge the coal is apparently absent. South from the railroad bridge the coal is again of its usual thickness and in normal relationships, so far as has been determined.

KANGLEY-HENANVILLE FIELD

The small area underlain by coal No. 7 in the vicinity of the Kangley bridge apparently is bounded on the west by the heavy sandstone which is exposed along Vermilion River, and is limited similarly by a sandstone to the east. The basin extends northeast beyond Henanville and south to the old Acme mine at Kangley. This is the Kangley-Henanville field of the Longwall District.

Mention has already been made of the existence of a local bed of coal between coal No. 7 and the heavy (Vermilionville) sandstone. In the Henanville District this lower coal is in places thick, but varies in its distance from the upper coal. At places in the old Henanville mine the two coals were in contact, the two beds having a combined thickness of about 9 feet. To the south near Kangley there is a bed of shale between the two coals and they can be worked separately.

COAL CITY-SOUTH WILMINGTON FIELD

This field is part of the eastern end of the Longwall District. It lies between the Ottawa-Morris field to the north and the Cardiff field to the south, into both of which it merges with indefinite boundaries. The relationships with the Morris area are possibly closest, and the correlations are made most accurately in that direction. Coal No. 2 is widespread in this field. Above it is a bed of shale or "soapstone" about 60 feet thick, which in places is quite sandy and elsewhere contains many fossil-bearing, ironstone concretions—the famous Mazon

Creek fossil horizon. This shale is overlain by carbonaceous beds, in places a thin coal seam, and then sandstone and sandy shale to the upper coal, which is apparently No. 7. As in the case of the fields already described the boundary between the Carbondale and McLeansboro formations is indeterminable, but not improbably it lies in the sandstone below coal No. 7, as in the Streator field.

OTTAWA-MORRIS FIELD

The transition from the stratigraphic sequence of the La Salle field to that of the Coal City field can be traced with but slight interruptions from the anticline to Morris. At Ottawa the "Coal Measures" are thin, only the lower 50 feet or so being left in the valley bluffs. The soapstone roof, characteristic of coal No. 2 in the La Salle region and also the black, fissile shale and the septarian zone above, can be traced at least as far east as Buffalo Rock. The soapstone is however about twice as thick, approximately 35 feet being measured at the clay mine of the Herrick Clay and Manufacturing Co. near Twin Bluffs. East from this location the strata lose more and more of their characteristic appearance near La Salle, and the "soapstone" continues to increase in thickness. Above the horizon of the fissile shale and septarian zone, which become less conspicuous, is another carbonaceous, sheety shale which is possibly about the same age as the blocky, carbonaceous shale found a short distance below the heavy sandstone bed at Lowell.

Between Ottawa and Marseilles the coal goes under Illinois River. At Marseilles it is about 60 feet below the surface, and the upper black, fissile shale is near the surface of the Illinois River flat. In the valley bluffs above the town a heavy sandstone, 60 feet or more in thickness, makes up the rest of the Carbondale section. The sandstone is thought to be the equivalent of the Vermilionville in the La Salle and Streator fields. A coal, possibly No. 7, is reported above this sandstone. The Marseilles section resembles both the Streator and Coal City sections, in thickness and in the disposition of the various strata.

Towards Seneca the heavy sandstone appears in the north bluff of the river, but because of the erosion of the upper part it becomes thinner eastward. About 30 feet of "Coal-Measures" sandstone underlies the town of Seneca directly below the surface deposit. It can be seen outcropping along the Illinois at the Big Four Railroad bridge. From Seneca to Morris much the same succession continues except that older and older rocks are brought to the surface in that direction, due to the slight dip to the west. At Morris the Carbondale is represented by 30 to 50 feet of shale which possibly represents the thickened

gray shale or "soapstone" normally above coal No. 2 in the La Salle field. The black, fissile shale and the septarian zone above are not

ILLINOIS COAL MINING INVESTIGATIONS BULL. NO. 10, PLATE V

and south along the east side of the pre-glacial Illinois-Rock River Valley. Southward the formation has been removed over the fold, at least as far south as Lowell and probably nearly to Leonore on the Illinois Central Railroad west of Kangley. East of the fold there is possibly a V-shaped area of McLeansboro, one side of the V, running

from a point near Leonore toward Marseilles, the other side extending from Marseilles toward South Wilmington. This area, however, is much more irregular than is indicated by this description, as several lines of pre-glacial drainage cross this triangle and apparently center in a deep, broad, valley which passes out of the district between Dwight and Streator. (See stereogram for position of this drainage line. Plate III). The formation is found in only three of the subdistricts into which the Longwall District has been divided.

LA SALLE-MINONK FIELD

The McLeansboro formation extends from about midway between the middle and upper coal beds (coal No. 5 and coal No. 7) to the top of the Pennsylvanian system in this field. It includes therefore coal No. 7 and the La Salle limestone, which is used extensively in the La Salle region for the manufacture of Portland cement. The formation is thicker in this field than elsewhere in the district, extending from about 300 to 600 feet above sea level in the vicinity of La Salle and Peru. The formation seems to be divisible into at least two parts and possibly into three. The lower part of the formation is predominately siliceous and is essentially a continuation of the upper part of the Carbondale formation. About 50 to 75 feet above coal No. 7 the character of the rocks changes from siliceous to predominately calcareous, and thin limestones and limy shales comprise most of the rest of the section. Because of a marked change in the character of the fauna in one of the upper limestones exposed in the bluff of Illinois River opposite La Salle, there is possibly some basis for the division of the formation. The fauna above is composed essentially of pelecypods and that below, of brachiopods.

Within the lower siliceous section of the McLeansboro formation the coal known locally as the "first" or "upper vein," No. 7 of the Illinois section, is the most constant member and is found practically everywhere in this field, except where it has been eroded. Erosion however has been extensive. It is in most places associated with a thick underclay which has been demonstrated to be of commercial importance in some places. Locally this clay exceeds ten feet in thickness. The coal is overlain by dark shale, which grades into a siliceous shale, and that into sandstone in places. This sandstone is locally known to cut down through the coal and to unite with the sandy strata below the coal. A description of the coal is to be found in Chapter III.

Near the base of the upper section of the McLeansboro formation and 50 to 75 feet above coal No. 7, is a rather definite limestone horizon thinner and less readily identified than the La Salle limestone, but apparently more widespread. This horizon is thought to be the same

as that of the Lonsdale[4] limestone in the Peoria area. This limestone has been found outcropping in the vicinity of Coal Hollow, Bureau County (sec. 17, T. 16 N., R. 10 E.), in Rocky Run east of Tiskilwa, at Sparland, and thence south toward Peoria, and possibly in the Streator field. In all places the relation to coal No. 7 is about the

FIG. 9. The La Salle limestone along Vermilion River showing the middle part of the formation (photo by Rhodes).

same. A similar relationship is reported by T. E. Savage to exist throughout Fulton County, though the coal and limestone are somewhat nearer together than at Sparland. The identification of this horizon in the drill holes is very impracticable. The limestone contains a large amount of argillaceous material, and it is apparently only under the influence of weathering that it hardens and appears as a definite ledge of rock, whereas a few feet back it is very fragmentary. Be-

[4]Udden, J. A., Geology of the Peoria Quadrangle, Illinois: U. S. Geol. Survey Bull 506, p. 39, 1912.

cause of this characteristic, the rock is likely to be interpreted by the driller as shale, or limy shale.

The upper section of the formation which contains the limestones and limy shales has one, and possibly two, economically important limestone horizons. The most important of these commercially is the La Salle limestone, which borders both Little and Big Vermilion rivers for several miles above their mouths, and which is used in the manufacture of Portland cement by three large cement mills located at Oglesby and La Salle. The limestone reached a thickness of 25 to 30 feet. This bed lies about 400 feet above coal No. 2 or 175 feet above coal No. 7. It has a very local distribution, being confined to a belt about two miles broad and extending parallel to its outcrop along the anticline from Bailey Falls on the south to the NE. ¼ sec. 28, T. 34 N., R. 1 E., three miles north of La Salle. The belt is much wider in the

FIG. 10. Strata at the horizon of the La Salle limestone in a gulley in Peru, showing the more siliceous phase.

middle than at either end.[5] In this area much of the rock has been removed by erosion along Illinois and Vermilion rivers and their tributaries. The same horizon extends farther westward, but the lithological change is considerable, so that the stratum loses its value as Portland cement rock within two miles of the outcrop. Along the Illinois bluff to the west the bed appears as either a very siliceous, dirty limestone, or as a more or less calcareous shale. Figure 9 shows the La Salle limestone along Vermilion River, and figure 10 the siliceous limestone.

Intermediate strata between these rather characteristic limestone beds are largely limy shales and thin limestones. The strata are so variable that a generalized section is misleading. The Freeman section (Plate IV, No. 7) is as representative as is consistent. Certain of the coal beds will be considered in greater detail in the discussion of the economic geology.

About 25 feet above the La Salle limestone and near the top of the McLeansboro formation there is 24 feet of shale divided into three beds which are reddish, bluish, and yellowish in color. This shale has been used to some extent in the vicinity of La Salle for the manufacture of brick. So far as known it exists only in a small area within the city limits of La Salle and Peru, and across the river opposite these towns in another limited tract. The same stratum probably extends along Bailey Creek above the Falls, but whether the shale is of the same character is not known.

STREATOR FIELD

The McLeansboro formation in the Streator field is exposed in numerous outcrops along Vermilion River. A probable part of this formation has been already described in the discussion of the Carbondale formation of the Streator field. As it is not practicable to separate the formations at a definite horizon, the base of coal No. 7 is used as a convenient plane of separation and one which is thought to be near the stratigraphic division plane. The description of the McLeansboro formation in this field will accordingly be limited to the strata above the base of coal No. 7.

As has been previously shown coal No. 7 does not underlie this field continuously, but is interrupted in places because of the increased thickness of the underlying sandstone, as for instance to the east and west of the Kangley-Henanville area. Freeman described the coal outcropping above Kangley bridge (see figure 8) and named it the Kirkpatrick coal, not believing that this bed was the exact equivalent

[5]Cady, G. H., Cement Making Materials in the Vicinity of La Salle, Illinois: State Geol. Survey, Bull., 8, p. 127, 1907.

of the Streator coal, or coal No. 7. It is not known definitely whether the sandstone barrier to the east entirely separates the coal of the Kangley-Henanville field from both the Streator field and the La Salle field, but there are indications that such is the case. At least, it is certain that the coal is different in appearance and is associated with different strata than in the Streator and Kangley fields. Although Freeman's distinction of the Kirkpatrick coal from the Streator or No. 7 coal may not be found justified, it seems probable that the Kangley-Henanville basin was largely isolated during the deposition of coal No. 7 so that conditions there differed from those in the adjacent parts of the district. Coal No. 7 is described in detail in Chapter III.

Above the coal is a light, bluish-gray shale 35 to 40 feet thick, used by several of the brick and tile companies in the vicinity of Streator. Above the shale is a shaly sandstone about 10 feet thick. The succession above this horizon is not accurately known as exposures are poor. Within 25 feet of the sandstone there lies locally a nodular, concretionary shale, which at one place at least hardens into a heavy nodular limestone 4 to 5 feet thick. This is possibly the equivalent of the Lonsdale limestone of the La Salle and Sparland districts. This nodular shale is noted at the north end of the road bridge over the Vermilion just below the Santa Fe Railroad bridge. At this place it is 50 to 60 feet above No. 7 coal. In sec. 18, T. 30 N., R. 4 E. large blocks of nodular limestone lie on the banks of Vermilion River for a distance of about one-fourth of a mile. Although these blocks are not in place, they could not have been moved a great distance and they represent the approximate position of the Lonsdale limestone. A limestone, probably the Lonsdale, outcrops in a very similar way in Rocky Run near Tiskilwa, large isolated blocks lying in the bed of the stream or along the sides of the valley.

Between 5 and 10 feet above the sandstone noted in the preceding paragraph there is present a seam of coal about 30 inches thick in a small area in the N. ½ sec. 18, T. 30 N., R. 4 E. The coal is underlain by fire clay and overlain by gray shale. The distribution of this coal has not been determined, but it seems to be very limited.

The strata overlying the limestone are not known. Within this district east of the anticline they have a very limited distribution, and are confined to Livingston County.

SOUTH WILMINGTON AND CARDIFF FIELDS

The distribution of the McLeansboro formation in this part of the Longwall District is indicated approximately by the distribution of coal No. 7 as shown in the map in figure 27. It is a small, narrow, arrow-shaped area running from a broader base in the Cardiff region to

a point near Mazonia. The strata have been removed to the east and west by pre-glacial erosion. The thickness remaining above the coal is in few places more than 50 feet and is as a rule much less, so that the formation is relatively unimportant. The formation in this field is composed almost entirely of shales, although one or two records show a thin limestone 3 to 5 feet thick, 15 or 20 feet above the coal.

SUMMARY

A section of the Pennsylvanian series of the Longwall District applicable to the different parts of the area would need to be of general character, presenting merely the salient features of the succession. It is thought that after the preceding review of the general geology of the different parts of the district the following statement will not be misleading:

(1) Coal No. 2 is of uniform character and widespread distribution so that it is rather easily identifiable in any of the fields.

(2) There is a simliar persistance of coal No. 7, although there is a greater variation in thickness and in the character of the associated strata than is true of the lower coal.

(3) The Lonsdale limestone is probably traceable from one point to another that is widely separated from it, but the identification is not readily made in drill records.

(4) So far as known no other single stratum is identifiable over the entire district.

(5) The Pennsylvanian system as a whole is lithologically divisible into three parts: the lower part is dominately shale, and contains one persistent bed of coal (No. 2) and several black "slates"; the middle part is dominately either sandstone or sandy shale, and includes two horizons where coal is likely to be found; the upper part is dominately calcareous shale and thin limestone and is barren of coal of any economic importance. This latter division contains a persistent nodular bed of limestone near its base.

(6) It is thought that any attempt to map the stratigraphic divisions, McLeansboro and Carbondale, in this district will be attended by uncertainty and inaccuracy because of the indefiniteness of the position of the contact of the two formations.

STRUCTURE

DEFINITION

The term *structure* as used in geology commonly refers to the attitude or "lay" of the rock layers, that is, whether they are flat lying, inclined, folded, or broken by faults. Structure of this kind can be

FIG. 11, *a*. Sketch of ideal landscape.

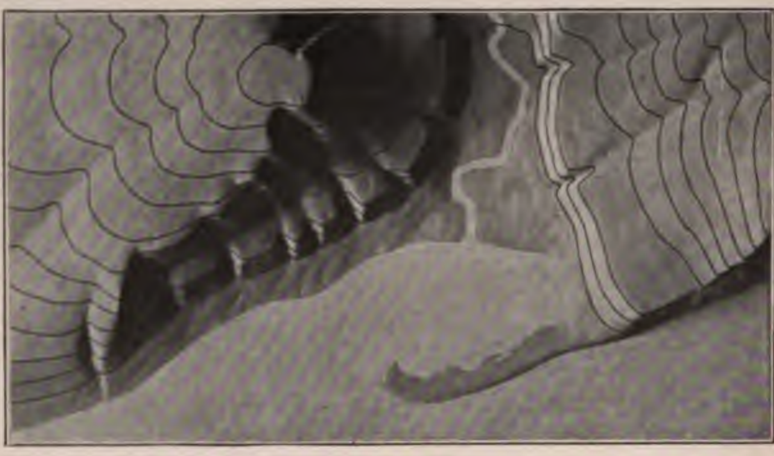

FIG. 11, *b*. Model of ideal landscape.

FIG. 11, *c*. Topographic map of ideal landscape.

represented by photographs and sketches, by diagrammatic cross-sections and block drawings, but most clearly and accurately by means of structural contours. As the use of contours to show differences in elevation or relief may not be familiar, the attention of the reader is called to the following explanation:

Use of Contours

The use of contours to exhibit geologic structure can best be explained to the reader by inviting attention to the similar use of contours to show relief or configuration of land forms.

The explanation can be based on the accompanying representations (Fig. 11*a*, *b*, and *c*) of an ideal landscape from the geological folios issued by the U. S. Geological Survey. Figure 11*a* represents a river valley between two hills. In the foreground is the sea, with a bay that is partly closed by a hooked sand bar. On each side of the valley is a terrace. The terrace on the right merges into a gentle hill slope; that on the left is backed by a steep ascent to a cliff, or scarp, which contrasts with the gradual slope away from its crest. In the model and map each of these features is indicated, directly beneath its position in the sketch, by contour lines.

Figure 11, *b* shows a model of the same landscape viewed from above. On this model lines have been drawn connecting points of equal elevation above sea level.

Figure 11, *c* shows only the level lines or contour lines. It is a contour map. The following notes may help to explain the use of contour lines.

1. A contour line represents a certain height above sea level. In this illustration the contour interval is 50 feet; therefore the contour lines are drawn at 50, 100, 150, and 200 feet, and so on, above mean sea level. Along the contour at 250 feet lie all points of the surface that are 250 feet above the sea, that is, this contour would be the shore line if the sea were to rise 250 feet; along the contour at 200 feet are all points that are 200 feet above the sea; and so on. In the space between any two contours are all points whose elevations are above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, and that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 feet but less than 200 feet above the sea. The summit of the higher hill is marked 670 (feet above sea level); accordingly the contour at 650 feet surrounds it. In this illustration all the contour lines are numbered, and those for 250 and 500 feet are accentuated by being made heavier. Usually it is not desirable to number all the contour lines. The accentuating and numbering of certain of them—say every

fifth one—suffices, and the heights of the others may be ascertained by counting up or down from these.

2. Contour lines show or express the forms of slopes. As contours are continuous horizontal lines, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing around spurs or prominences. These relations of contour curves and angles to forms of the landscape can be seen from the map and sketch.

3. Contour lines show the approximate grade of any slope. The vertical interval between two contours is the same, whether they lie along a cliff or on a gentle slope; but to attain a given height on a gentle slope one must go farther horizontally than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

Significance of Structural Contours

A structure contour map is similar to the surface contour map already explained. It differs from the surface contour map in showing the elevation of the top of a selected stratum rather than the elevation of the surface of the ground. The detail of the structure contour map is much less than that of the surface contour map, because in the latter case the elevations of all points on the surface can be readily determined, whereas in the case of the structure contour map the elevation of the stratum mapped is known only at outcrops and where it has been reached by the drill or by mine shafts and the map must be constructed from more or less scattered data.

The Accuracy of Structural Contours

In the Longwall District the structure contours shown on the map (Plate I) are based upon the top of coal No. 2. The quality of the contouring is determined first, by the number and distribution of observations; second, by the reliability of geological data, which involves the accuracy of statement by those from whom the information is sought, the accuracy of the location of the drill holes, and the correctness of correlation of strata at outcrops and in drill holes; and third, by the method of determining the elevation of the bed to be contoured. Three methods are used by the Survey to determine elevations. (1) Instrumental leveling, by which method the limit of error lies within one-tenth of a foot. Where the position of the drill hole is known only in a general way more or less inaccuracy results, but the observer attempts to eliminate errors greater than two or three feet. (2) Elevations obtained by hand-level from adjacent bench marks. The error in extreme cases amounts to 5 feet, but most elevations are cor-

rect within 2 or 3 feet. (3) Elevations estimated from topographic maps. Elevations estimated from accurate contour maps may possibly be in error as great as the contour interval which varies from 10 to 20 feet in the different types of maps. These maps are of two grades of accuracy. The new La Salle, Hennepin, Ottawa, and Marseilles topographic sheets (1910-1914) are considerably more accurate than the old Morris and Wilmington sheets made twenty years ago. These latter are of about the same degree of accuracy as a series of county contour maps prepared by Professor C. W. Rolfe for the Board of World's Fair Commissioners in 1893 and based upon railroad elevations and barometer readings. In rough country they are unsatisfactory. Unfortunately many of the errors in the contours of the older maps are more than the contour interval, hence it is possible that elevations estimated from these maps are inaccurate to an extent of 25 feet. In a few cases rough estimates of elevation are based upon railroad elevations of the neighboring stations. This is not done when any marked surface irregularity is known to be present.

The surface of the coal is somewhat more irregular than the contours indicate. There are local variations as great as 10 or 15 feet in the elevation of the coal that cannot be shown because of the large contour interval. The interval is sufficiently large, also, to minimize the effect of slight errors in elevation to which the map is liable, at the same time it is sufficiently adequate to show the main structural features of the district. If a knowledge of the detailed structure of a small area is desired, more careful leveling, more numerous observations, and a map having a smaller contour interval is necessary.

The most accurately mapped area within the field is that of the La Salle and Hennepin quadrangles (see Plate I) where the contours on coal No. 2 are thought to be accurate everywhere within 10 feet. South of these quadrangles the companies who drilled the holes obtained accurate elevations for the prospects in T. 31 N., R. 1 W., and for a number of holes in the various townships in R. 2 W. In the vicinity of Streator the State Survey has obtained instrumental elevations of all the mines of coal No. 7 at the various brick and tile pits, and of a few drill holes. The flatness of the upland around Streator reduces the chance for great error in this area, however. All elevations within the Coal City-South Wilmington field are determined by estimate from topographic maps. This area is a plain, sloping gently toward Illinois River, and the changes in elevation are slight in any direction, so that the chances for error are not great. The same conditions hold in the Morris area. In the Cardiff field accurate elevation on a company datum had been determined for the various drill holes and shafts. These elevations were approximately adjusted to sea

level and were incorporated in the map. The accuracy of the elevations of the various drill holes shown on the map (Pl. I) is indicated by the different patterns, as explained in the legend of the map.

Having determined at numerous points the elevation of the top of the coal, contour lines are drawn on the assumption that slopes between adjoining points of different elevations are uniform. An element of error enters here, which increases with the distance between points, for it is obvious that between two points of observation one-fourth of a mile apart, there is less chance for irregularities in the elevation of the coal than between points a mile apart. For this reason, the structure map as constructed, has been slightly modified to eliminate unnatural angles that would appear if the data employed were strictly followed.

Uses of the Structure Map

The primary purpose of the structure map (Plate I) is to show the structural features. The coal stratum slopes away or dips as shown by arrows from contour lines of higher elevation to those of lower. Remembering that the strata slope away from the anticline or upward fold, toward the east and west (see stereogram), and from the west side of the district toward the syncline or downward fold, the local relationship of structure can be readily determined.

In addition to the usefulness of the structure contour map in showing the lay of the coal, it can be used to determine the approximate depth of the coal bed. In case the depth of the coal is desired at some point crossed by a structure contour line, it can be readily calculated by subtracting the elevation shown on the contour line from the surface altitude. If the point lies between two contour lines, its relative distance from them is observed, and the elevation of the coal approximated accordingly, after which process the regular calculation can be made.

One of the special services of the coal structure map in Illinois has been to determine the possible areas of oil and gas accumulation. It has been found as a rule that structural features affecting the "Coal Measures" affect also the underlying rock to a considerable depth in the same way, though possibly to a greater or less degree. A relationship of areas of accumulation to anticlinal folds and domes is known to exist, and the fact that, at least in some places, domes in the coal strata indicate conditions favorable for oil and gas has given added value to structure contours on the coal beds.

There has been no adequate testing of this area for petroleum except indirectly by the deep water wells. These wells are located in many places in the Longwall District, many penetrating to the

Galena-Trenton limestone, several to the Lower Magnesian limestone, and three or four to the Potsdam or Cambrian sandstone. If oil or gas was discovered in these wells it was not in sufficient quantity to stimulate further drilling. The few oil prospects are not any deeper than many of the artesian wells and no more advantageously located. None are known to have been successful. It is reasonably certain that where these artesian wells are located oil or gas is not likely to be found. Various apparently unsuccessful "wild-cat" explorations have been made within the area. These wells were located near the following places: southeast of Streator, and at Odell in Livingston County, at Minooka in Grundy County, at Lowell and Tonica in La Salle County, and at Tiskilwa in Bureau County. Others may have escaped notice. (For discussion of drift gas wells see page 57.)

La Salle Anticline

DESCRIPTION

The La Salle anticline is the most conspicuous structural feature of northern Illinois. Its continuation into southeastern Illinois is marked by the oil and gas fields of Clark, Crawford, and Lawrence counties which are situated along its crest. The anticline crosses Illinois in a northwest-southeast direction, forming a broad arch along the Illinois-Wisconsin line. The fold is steeper and narrower, but well developed, between Oregon and Dixon in Ogle and Lee counties. Between Dixon and the La Salle region the fold is again broader, and the crest lower. Near La Salle and for a distance of about 10 miles the fold is sharp, and the west limb very short, being less than a mile in length. The crest of the arch, from which strata slope in all directions at various angles, seems to be about where it is crossed by Illinois Valley; thence to the south, as to the north, the fold pitches downward, and the crest becomes less and less sharp. Through Livingston County it seems to continue as a broad arch. Its character farther south is not well known until it reaches the main oil fields as a sharp anticlinal fold.

Within the area of the Longwall District, the anticline is best exposed along the Illinois and the two Vermilion rivers. The Illinois valley crosses the fold at a right angle, so that the entire thickness of the "Coal Measures", 125 feet of Galena-Trenton limestone, the entire thickness of St. Peter sandstone, and about 100 feet of the Lower Magnesian limestone is exposed within a distance of less than a mile along the north bluff of the river in the vicinity of Split Rock (NW. ¼ sec. 13, T. 33 N., R. 1. E.). Along Little Vermilion River similar sections passing from the Pennsylvanian through Galena-Tren-

ton limestone, St. Peter sandstone, and into the Lower Magnesian limestone, can be found. Since the anticline pitches southward the sections exposed along Big Vermilion River do not include formations older than St. Peter sandstone, as at Deer Park. That the Lower Magnesian limestone is relatively close to the surface, however, is shown by drilling.

Our information in regard to the details of the structure has been considerably enhanced by the development in the Black Hollow mine of the Illinois Zinc Company, near Deer Park. The workings of this mine have been carried down the west limb of the fold practically from the top of the arch to the bottom of the trough. Observations on the dip have been taken constantly under the direction of Mr. J. A. Ede, Mining Engineer in charge, so that the structure of the coal bed at this place is very well known. The coal at the entrance of the slope has a dip of about 10 per cent (6°); for the first 1150 feet in the direction of slope the dip increases to 15 per cent (9°); in the next 200 feet it increases to 34 per cent (20°); in the next 100 feet to 71 per cent (37°); and in the next 250 feet to 100 per cent (45°). The physical changes in the coal resulting from the folding have been studied in considerable detail by Mr. Ede, and he reports a harder, more brittle, and a somewhat shattered coal on the flank of the fold than is found near the trough. The roof shale in the mine is much broken and difficult to control, and the floor is exceptionally liable to heave.

Of special interest is a comparison of the structure of the surface rocks with that of the strata in the mine. The La Salle limestone is exposed along Vermilion River practically directly over the observations in the mine at the foot of the slope. It is apparent that the high dips which characterize the coal do not continue upward and affect all the overlying strata. It is not clear whether this is because there were two periods of folding, one during the Pennsylvanian period and one later, or whether it is because of the softer and incompetent character of the lower rock which would accordingly yield to minor folds that would not have a very great horizontal distribution. The fact that small faults cut the coal in the vicinity of the anticline, but apparently are not distributed throughout the measures as a whole, seems to indicate that the weaker strata were more severely affected by the folding than the more resistant layers, rather than that there were two periods of folding since the deposition of the coal.

The problems involved in mining coal in the Black Hollow mine where there are constantly changing conditions of dip, broken roof, and soft floor, are such as are not encountered elsewhere in the State.

Exceedingly interesting mining methods have been put into practice in order to reach the bottom of the incline. These methods have been described to some extent by Mr. S. O. Andros in Bulletin 6, Mining Practice in District I.

The difficulties encountered in this mine are so well known that it is improbable that other mines will undertake the development of the coal under similar conditions, at least not until the value of the fuel has considerably increased. It is to be remembered, however, that the closeness of the fold probably decreases to the south, so that mines opened along the anticline in southern La Salle County would probably not encounter conditions so difficult as are found in the vicinity of La Salle.

HISTORY OF THE LA SALLE ANTICLINE

The anticline affects all exposed strata in the region older than the Pleistocene. Two periods of folding are evident, one pre-Pennsylvanian and the other post-Pennsylvanian. The pre-Pennsylvanian folding certainly took place after the deposition of the Galena-Trenton limestone, and probably before the deposition of the Maquoketa shale

FIG. 12. The unconformity between the Pennsylvanian series and the St. Peter sandstone at Split Rock. The dip of the Pennsylvanian (12 to 15 degrees) is shown by the ledge of sandstone outcropping under the stairs. The dip of the St. Peter sandstone (20 to 30 degrees) is shown in the strata in the foreground.

It seems to have been about contemporaneous with the arching of the Cincinnati anticline in Ohio, Indiana, and Kentucky.[6]

The age of the post-Pennsylvanian and pre-Pleistocene folding is not known exactly. There is some doubtful evidence that there was movement during the Pennsylvanian. The greater angle of dip of the strata associated with coal No. 2 as compared with the strata of the upper part of the McLeansboro formation has been described. This, as has been said, may be due to another cause. There is also the

FIG. 13. Split Rock from the east showing the dipping St. Peter sandstone. The picture shown in Fig. 8 was taken at the west end of the tunnel shown in this picture.

difference in thickness of the Pennsylvanian series on the two sides of the anticline that is suggestive of movement after the deposition of coal No. 2 and before the deposition of coal No. 7. If the relative thinness of the "Coal Measures" to the east is due to elevation on that side of the anticline, the movement apparently occurred at about the time of the break or change in deposition which inaugurated the McLeansboro epoch.

Because of the pre-Pennsylvanian period of folding along the anticline, the "Coal Measures" overlie strata varying in age from the Niagaran limestone and possibly Devonian shale to Lower Magnesian limestone (see pages 19 to 23). As the older strata have been affected

[6]Savage, T. E., Unpublished paper on the Maquoketa of Illinois, presented before Ill. Acad. Sciences, 1912. For a discussion of the age of the fold see also Cady, G. H., Geological sequence in the vicinity of La Salle as revealed by recent drilling: Trans. Ill. Acad. Sci., Vol. V, p. 87, 1912.

by two movements these strata show higher angles of dip along the fold. The "Coal Measures" at Split Rock dip 12 to 15 degrees, whereas the adjacent St. Peter sandstone slopes with twice that angle. Figure 12 shows the relationship of the "Coal Measures" to the older rocks. Figure 13 shows the character of the dip in the St. Peter sandstone.

TROUGH WEST OF THE ANTICLINE

Just as the crest of the anticline pitches to the north and south from the region of Oglesby and La Salle, the trough west of the fold becomes shallower in the same directions. The elevation of coal No. 2 in the various mines from La Salle south to Minonk reveals the character of the slope of the trough parallel to the anticline. At La Salle the coal has an altitude of 109 feet, at Oglesby 100 feet, at Wenona 123 feet, at Rutland 197 feet, and at Minonk 219 feet. Apparently the rise is slight as far south as Wenona, and from that point increases rapidly. Northward from La Salle the trough rises rapidly and practically loses its character about where the anticline crosses the La Salle-Bureau county line. Although there may be no causal relationship between the facts, it seems that the best coal No. 2 in the La Salle-Minonk field lies in the trough.

MINOR STRUCTURAL FEATURES

All the structural features not associated with the anticline are of minor importance as compared with the main fold. The greatest irregularities are found in the Coal City-South Wilmington region. Differences of 50 feet in the elevation of coal No. 2 within distances less than a mile have been encountered near Coal City (see page 73). The larger features of the structure include a domelike elevation on the west side, and a depression through the center of the field. The combined features resemble a wave in the general eastward rise of the coal from an axis of low elevation that runs southward from Marseilles.

The beds near the western margin of the district like those near the eastern rise toward the outcrop. The rise between Depue and Bureau, if the correlations are correct, amounts to about 100 feet in 1½ miles. This area of steeper dip on the west edge of the district continues northward, but to the south the dip becomes gentler. It may be worth noting that the 300-foot contour line follows closely the Illinois Valley below the bend.

FAULTS

So far as the field in general is concerned no faults of importance are known. Displacements affecting the thickness of the coal have

been encountered in some of the mines, but fracturing of great thicknesses of strata does not seem to have taken place even along the La Salle anticline. Several small faults will be considered in the descriptions of the coal (see page 73).

GLACIATION IN THE LONGWALL DISTRICT

The Pre-Glacial Surface and the Thickness of the Drift

Glaciation had a widespread effect upon this district. From the stereogram (Plate III) some idea of the thickness of the glacial deposits in different parts can be gained. Sufficient drift is present everywhere away from the streams to give the country a distinctly glacial topography. Hard rocks control the topography as a rule only where erosion has removed the glacial material along Illinois Valley and some of its tributaries.

Mine shafts except in the new, rock-bordered valleys, have usually been sunk through a considerable thickness of drift, some of which is very likely to be water-bearing gravel. In general it is true that where the surface elevation exceeds an altitude of 600 feet, drift is probably present. Where the La Salle limestone outcrops along the anticline, it reaches an altitude of 625 feet, as does the St. Peter sandstone and the Lower Magnesian limestone near the anticline; but these are unusual altitudes for the rock surface.

The pre-glacial surface has a relief of 250 to 300 feet and varies in altitude from about 650 feet near the anticline to about 350 feet

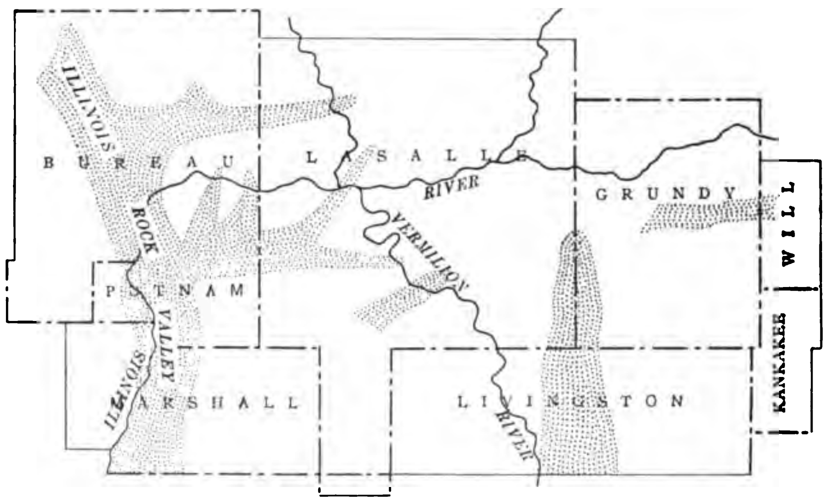

Fig. 14. Sketch map of Longwall District showing approximate position at pre-glacial valleys.

along the Illinois-Rock or Illinois-Mississippi valley. Leverett[7] has described the pre-glacial valley which ran north and south on the west side of this district. The center of the valley passes about under Princeton and Bureau in Bureau County, under Hennepin, Putnam County, and a little east of Lacon, Marshall County. The older valley then, although it ran in the same direction as the present Illinois below the bend, lay slightly to the east. Lateral valleys drained toward this pre-glacial stream on either side (see figure 14). One valley apparently extended east along a line running from Hennepin to north of Granville and Cedar Point, where two branches entered, one from the direction of Oglesby and another from the direction of Lowell. South of Cedar Point in sec. 8 the surface of the rock has an altitude of about 460 feet, and the drift has a thickness of 170 feet. This valley seems to lie about in the position of Allforks Creek as it runs from the east. There was a similar valley north of the present Illinois, running from the east between the present positions of Cherry and Ladd. It apparently started east of Little Vermilion River, since the Vermilion crosses it about two miles south of Troy Grove in secs. 10 and 11. Valleys tributary to these secondary valleys extended to the north and south, and some of them are now crossed by the present valleys. For instance, the Illinois crosses an old valley which drained to the south from the area just east of Spring Valley. The older valley is now filled with gravel and sand and till, but its cross-section is clearly shown, especially on the south bluff, by the shape of the glacial deposit. There are several interruptions in the continuity of the "Coal Measures" between La Salle and Marquette, where Illinois River crosses drift-filled valleys.

Eastward from the anticline these interruptions in the rock bluff above the river are rare. At Utica there is evidence of a pre-glacial valley along Clark Run north of town. This possibly is a continuation of the valley intersected by the Illinois north of Oglesby. Between Utica and Ottawa the rock seems to be continuous along the Illinois bluff. The drift at the end of Fox River Valley is thick, but does not extend below the river. The rock surface rises toward Marseilles and falls again to the east. At Seneca there is no rock in the river bluffs, but the "Coal Measures" are only a few feet below the surface upon which the town is located. Eastward toward Morris the topography is subdued but the rock surface rises somewhat in that direction. From Seneca southeast toward Mazon in Grundy County and southwest toward Kernan in La Salle County, the drift is thick, and the rock surface has a correspondingly low altitude. The direction and the position of the pre-glacial drainage lines have not been determined

[7]Leverett, F., Illinois Glacial Lobe: U. S. Geol. Survey Mon. 38, p. 483, 1899.

for this area, but apparently the drainage was to the south into Livingston County. The elevation of the rock floor in the vicinity of Ransom is about 350 feet above sea level, as determined by a well on the farm of Ernest Pancake 2½ miles east of town. About 2 miles south of Mazon where the surface elevation is about 600 feet, 160 feet of glacial drift was encountered. In the intermediate area the drift is everywhere reported thick and the altitude of the rock very inconstant. Because of this fact the coal underlies the drift only in patches and has a very uncertain and irregular distribution. This strip of thick drift extends southward into Livingston County between Dwight and Streator.

In the Coal City field the coal outcrops to the north along the side of a pre-glacial valley that runs east and west, north of Carbon Hill. Some of the mines at the north end of the field have been made dangerous by beds of sand and gravel that reach the coal and are a source of quantities of water.

At Cardiff the drift is from 80 to 100 feet thick and obscures the very irregular distribution of the upper coal (No. 7). This bed is near the top of the "Coal Measures," however, and is apparently of no economic importance.

Mention has already been made of the pre-glacial valley that runs from near Lowell toward the west. Upstream about three miles above Lowell a wide, drift-filled valley, the bottom of which has not been reached by the present stream, is crossed by the Vermilion (see stereogram, Plate III, and fig. 14). The bearing of this valley is not known, but if it follows a southwesterly course toward the Illinois, some of the coal beds must have been removed along its course. Where it crosses the Vermilion, strata at the horizon of coal No. 7 have been removed, and possibly to a limited extent coal No. 2, though this is not certain. If the pre-glacial valley continues in a westerly direction the lower coal is almost certainly removed over the fold along the line of erosion.

Upstream from this locality through La Salle County the river bluffs are lined on one side or the other with rock. In the SE. cor. sec. 1, T. 30 N., R. 3 E., Livingston County, at the dam above the pumping station of the Streator Aqueduct Co., a thick filling of drift was noted in the valley.

In the vicinity of Sparland the Pennsylvanian rocks outcrop in the bluff above town, and the modern Illinois Valley apparently occupies the west side of the pre-glacial Rock-Illinois valley. Below Lacon and for several miles to the east, thick deposits of drift are the rule. In the explorations that have been carried on east of the Illinois in R. 2 W., the lowest altitude at which the surface of the rock has been

encountered is 350 feet above sea level about two miles west of Granville. Several holes to the south indicate elevations varying from 367 to 400 feet for the surface of the rock. The east slope of the old valley seems to lie through the west side of R. 1 W., where elevations of the rock surface vary from about 450 on the west to about 525 and 550 on the east. At Toluca and Wenona the drift is about 100 feet thick, and the surface of the rock has an altitude of about 600 feet.

North of Illinois River in Grundy County the thickness of the drift varies considerably and increases for the most part toward the northwest.

For more detailed discussion of the drift in the various counties, the reader is referred to Monograph XXXVIII, U. S. Geol. Survey.

Glacial Topography of the Longwall District

There are four conspicuous topographic features that are controlled by the drift or the modified drift: till plains, moraines, lake plains, and terraces. These have been described by Leverett in part, and in more detail, locally, in a folio on the La Salle-Hennepin quadrangles which is in preparation.

The upland surfaces are in general relatively flat or only gently rolling till plains. It is not unusual to hear the term "plateau" applied to the upland above the Illinois. A surface of conspicuous flatness surrounds the city of Streator, another borders the Chicago and Northwestern Railroad which runs north from Spring Valley. The surface is nearly level west of Fox River for six or eight miles.

Interrupting the continuity of these level tracts are several rather conspicuous, more or less concentric morainic ridges (see stereogram, Plate III). Along these ridges the drift is commonly thicker than elsewhere, and the surface material more largely clay than gravel and sand. The drift ridges or moraines seem to have no relation in their distribution to the underlying rock surface.

The third type of glacial topography is that arising from combined lake and glacial action—the lake plains. The most conspicuous of these is the Morris Basin, surrounding the town of Morris and merging toward the southeast into a similar plain bordering Kankakee River and known as Lake Kankakee. Sand hills formed by blown sand are not uncommon on the east side of the Morris Basin and on the Kankakee Plain.

Along Illinois River below the bend at Bureau there are large gravel terraces of about uniform altitude, which represent valley filling at the time of one of the glacial advances. As these terraces lie above the pre-glacial valley, most of the surface deposits underlying them are thick, and extend down to an altitude of about 400 feet above sea level.

Similar terraces, though on a much smaller scale, are found along practically all the streams of the district, at least as far east as the mouth of Fox River, and still farther up that stream. East of the bend on the Illinois the gravel is confined almost entirely to streams tributary to the major stream. These gravel deposits, especially below Bureau, are a very important source of road metal and ballast.

These four topographic features resulting from glacial action are the most conspicuous of the district. Since glacial time streams have cut more or less deep valleys into the plains and through the morainic ridges. The Illinois has been especially effective because of the large amount of water it received for a long time while it served as an outlet to the Great Lakes. The depth to which the Illinois has cut its valley increases greatly west of the La Salle anticline in the Pennsylvanian rocks. Recent exploration near La Salle by the Matthiessen and Hegeler Zinc Co. shows an extreme thickness of about 90 feet of alluvium in the flood plain south of the city. The depth seems to increase somewhat toward the anticline, as a thickness of about 130 feet has been reported about on the line of the fold. The rock floor of the valley from here rises very rapidly to a point about a mile east of Little Rock, where the channel of the present Illinois is cut into rock. We have no data on the depth of the alluvium in the flood plain of the Illinois between Peru and the bend at Bureau. Below that point it is impossible to distinguish between Illinois Valley alluvium and the material filling the pre-glacial valley.

Character of the Drift

There are two kinds of glacial deposits, till and stratified drift. The greater part of the area is covered with till, which is in most places a rather stiff clay containing stones scattered throughout, and commonly called "hardpan" by drillers. In this district there are tills of several glacial advances, the lower clays being as a rule somewhat harder than those above. A sudden increase in hardness of the "hardpan" in drilling operations is due commonly to the penetration of an older till. In many places the different tills are separated from one another by layers of gravel (see record p. 113). It must not be supposed that all the tills are present in each section of the drift, for the occurrence of each is very irregular.

Most of the stratified drift is concentrated along drainage lines. Old valleys are likely to contain considerable amounts of porous gravel interbedded with the till, as the area seems to have been affected by several advances of the ice each of which deposited its layer of gravel and till. Where the drift is thickest it is not uncommon to find several layers of till separated by beds of water-bearing gravel, and in places

even beds of black muck representing buried soils. In the vicinity of Princeton, Bureau County, a great many water wells that penetrate 100 to 300 feet of drift encounter beds of gravel that yield gas. The source of the gas is apparently the buried soils or mucks associated with the gravel. Drift wells that yield more or less gas are located also in the southern part of Grundy County near Kinsman, near Tonica in La Salle County, near Granville in Putnam County, and probably elsewhere.

From the preceding discussion it is obvious that the distribution of the glacial deposits has economic significance. Glaciation has concealed the outcrops of the important horizons so that their area is not readily ascertained; it has imposed a covering of till and stratified drift over the surface, the thickness of which depends somewhat on the type of the deposit; it has effectively concealed the position and direction of lines of pre-glacial drainage which have a marked control on the areas of the coal beds; and it has brought to the region great quantities of sand and gravel that are easy of access.

CHAPTER III—ECONOMIC GEOLOGY of COALS AND ACCOMPANYING STRATA

NAMES OF COAL BEDS

As designations for the Illinois coal beds, the State and Federal Surveys have in general preferred place names to numerals. Hence we have introduced for No. 7 coal, Danville coal; for No. 6 or the "blue-band" coal the local names, Herrin or Belleville coal; for coal No. 5, Springfield or Harrisburg coal; and for No. 2 coal, Murphysboro or La Salle coal. The place names have been selected because of the characteristic development of the coal bed in the locality indicated. Since the numerical system of nomenclature is more established, it has not been rejected by the State Survey in the various reports, and it will be used wherever greater clearness will result. It is the feeling that since most of the place names for Illinois coal beds are taken from towns not within the Longwall District, a consistent adherence to the numerical nomenclature throughout, with proper reference and correlations, should be the rule in this report.

DISTRIBUTION OF COALS

The coal beds of the Longwall District are at least 6 in number. These are No. 2, No. 5, No. 6, No. 7, the thick bed at Cardiff, and a local bed present in a small area in Livingston County southeast of Streator. In addition there are a few thin beds of little or no economic importance.

The bed most extensively mined is coal No. 2 which is everywhere worked by the longwall method. This coal is known at La Salle as the "third-vein" and in the Coal City-South Wilmington field as the Wilmington coal. This is the bed worked at La Salle, Spring Valley, Ladd, Cherry, Seatonville, Marquette, Oglesby, Deer Park, Granville, Cedar Point, Standard, Wenona, Rutland, Minonk, Toluca, Eureka, Sparland (one mine), Streator (two mines), Morris, Coal City, South Wilmington, and Cardiff. Coal No. 2 is thickest in the trough west of the La Salle anticline and in the Coal City-South Wilmington field; elsewhere it becomes thinner toward the outcrop, especially in the vicinity of Bureau in Bureau County, and east of the anticline and north of Illinois River. In this last-named area, besides being thinner than elsewhere, the coal has a very thin roof so that it

is probably of no value commercially. Also south of Marseilles and Seneca, there is an area where the commercial recovery of the coal is rendered doubtful by its irregular distribution resulting from preglacial erosion. Over the rest of the Longwall District coal No. 2 is exceedingly regular and constant. It underlies about 1800 square miles.

Coal No. 5 is confined to the La Salle-Minonk field but is not continuous. It has been worked somewhat in the La Salle region and is known locally as the "middle" or "second vein." The Matthiessen and Hegeler Zinc Co. is operating the only mine in this bed at present, though it is only since the Cherry disaster that the No. 5 coal bed was abandoned at the Cherry mine. Formerly it was worked at several of the shafts in the vicinity of La Salle among which are the shafts of Cahill Coal Co. and Oglesby Coal Co. This coal bed has an irregular distribution, and it is impossible to determine its total area with accuracy. Although the horizon of coal No. 5 is more widespread than that of coal No. 7, the lower coal itself is not present over considerable areas, so that it underlies an area less in extent than that underlain by coal No. 7, or about 500 square miles.

Coal No. 6 is present in the vicinity of Sparland. South from Sparland it becomes more important and reaches a workable thickness at Chillicothe. A thin coal bed, which in places combines with coal No. 7, is found at Streator, especially in the Kangley-Henanville field. This coal is known locally as No. 6, but it is very doubtful whether the correlation is correct. Coal No. 6 consequently is relatively unimportant in this district, and can practically be neglected in a consideration of the coal resources of the region.

Next to coal No. 2, coal No. 7 is the most widespread coal bed in the district. It is mined at Streator and Sparland, and was formerly worked in the La Salle field. This coal bed is known as the "Streator coal" at Streator, and as the "upper" or "first vein" at La Salle and Sparland. The area underlain by this coal is equal to about one-third that underlain by the lower coal, or 550 square miles.

In the vicinity of Cardiff there is an important bed of coal a few feet above coal No. 2, and it is known locally as the "thick vein". So far as known, the area underlain by this coal does not exceed 3 or 4 square miles.

Southeast of Streator in sec. 18, along Vermilion River a coal about 30 inches thick has been worked at local banks. This coal seems to lie 40 to 50 feet above coal No. 7 and below a bed which is possibly at the horizon of the Lonsdale limestone. The area underlain by this coal is not known, but it probably is small.

CORRELATION OF COALS

Methods of Correlation

The correlation of strata from place to place where the outcrops are discontinuous is accomplished by two methods. Of these two the paleontological method is the most convincing. The discovery that a certain fossil or association of fossils is characteristic of a certain bed makes it possible to identify the same bed elsewhere. The presence of a certain species of *Fusulina* in the limestone over coal No. 6, but not found in limestones associated with other coal beds, definitely identifies No. 6. The shale overlying coal No. 2 carries certain fossil plants which identify this horizon from Murphysboro to the La Salle region.[1] Unfortunately our present knowledge of the "Coal Measures" does not warrant many such definite correlations, so that for the most part we are limited to the second method of correlation, or the comparison of the physical characteristics of the coal and associated strata, to identify the coals in the different fields. Similarity of interval between coal beds is an aid to correlation. Because of the relative uniformity in dip of the Illinois "Coal Measures" over large areas, identification of strata can commonly be made with reasonable correctness on the basis of similarity in elevation and thickness when points of observation are not separated by more than two or three miles. The greater the number of drillings the greater the safety in this method.

Correlation of Coals of the Longwall District

COAL NO. 2

Coal No. 2 of the Longwall District is correlated with No. 2 of western counties and of the Jackson County area on the basis of plant fossils in the roof shale. The same bed is recognized under a different number in western Indiana. Within the district the coal and associated strata have fairly constant physical characters which are described in a later part of the chapter.

COAL NO. 5

So far as known coal No. 5 cannot be correlated over the State by means of fossils. In some areas but not in the northern district it has a rather constant interval below coal No. 6. In the western part of the Longwall District the coal lies from 150 to 206 feet above coal No. 2, and variations are shown in Table 2. "Horsebacks" or

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[1] White, David (U. S. Geol. Survey), Paleontological Work in Illinois in 1908; Ill. State Geol. Survey, Bull. 14, p. 293, 1909.

clay veins in the coal resemble those in No. 5 of the Springfield area; the roof materials are also similar. The characters of the coal bed and accompanying roof and floor strata are described on later pages of this chapter.

COAL NO. 6

Coal No. 6 is the most readily correlated of all the coal beds in the State where it exists under normal conditions. It is called also the "blue-band" coal because of a thin bed of shale or clay ½ inch to 6 inches in thickness which lies in most places 12 to 18 inches from the base of the bed. Commonly also a limestone cap rock is found above the coal at intervals varying to a possible maximum of 15 to 20 feet. This limestone contains a species of *Fusulina* which in size and shape resembles a slender grain of wheat. The coal where typically developed averages 7 to 9 feet thick, has a top bench 12 to 36 inches thick, an intermediate bench, and a bench below the blue band. Coal No. 6 is not typically developed in the Longwall District. The coal described as No. 6 near Sparland has a limestone cap rock resembling that above coal No. 6 in the Peoria region and elsewhere in the State, but no *Fusulina* was found even after considerable search. The coal where observed was only about 2 feet thick, and there seemed to be no blue band. The only adequate reason for correlating this bed with No. 6 is its apparent continuity with the No. 6 coal at Chillicothe. The coal developed in small areas in the vicinity of Streator and in some places combined with the overlying coal No. 7, is thought to be local. Descriptions of No. 6 coal and accompanying strata are presented later.

COAL NO. 7

The correlation of coal No. 7 (Streator coal) in the Longwall District with coals similarly numbered in the Danville area and the Peoria region, is doubtful. It is the only thick bed in the McLeansboro formation as now defined. The usual means of identification of this coal in the Longwall District is not by physical characteristics, nor by fossils, but by its position 25 to 70 feet below the Lonsdale limestone. The interval is about 50 feet at Streator and in the La Salle-Minonk field. Apparently this limestone outcrops in Rocky Run near Tiskilwa and along Bureau Creek east of Princeton.

The coal seems to vary so much even locally, that physical characteristics are of no service in identification. There is reason for believing that coal No. 7 represents, not a single widespread bed, but a number of beds distributed locally and lying at about the same horizon.

PHYSICAL CHARACTERISTICS AND DISTRIBUTION OF COALS AND ASSOCIATED STRATA

Coal No. 2

DISTRIBUTION AND THICKNESS

Coal No. 2 underlies approximately 1800 square miles of the Longwall District, and is or has been minable under 1200 to 1400 square miles. The coal varies in thickness from less than 1 foot to 54 inches, but in general is very regular. The average thickness in the La Salle region is 42 inches, and in the Coal City region about 37 inches. Between Deer Park and Ottawa the thickness ranges from 24 to 36 inches and northward along Fox River it diminishes to less than a foot near the northern limit of the district. Thin coal also underlies areas in southern Bureau and in Putnam counties.

The thickest observed section is in the Oglesby mine, where the thickness is between 4 and 5 feet, but is due to overthrust faulting. In the adjacent Black Hollow mine of the Illinois Zinc Co., unusual thicknesses have been encountered near the foot of the anticline.

PHYSICAL CHARACTERISTICS

Coal No. 2 is a long-grain coal, splitting most readily parallel to the bedding and having cleat everywhere poorly developed. The coal is relatively hard but brittle, the top coal being harder than that below, where there is any difference.

The coal bed is interrupted by thin layers, lenses, or balls of sulphur (pyrite or marcasite), mother coal, and dirt, and in places by bone coal. The bedded impurities do not make up a large percentage of the coal. In the La Salle region, at least, this is the cleanest of the three coal beds.

There follow a number of detailed observations made on the coal bed in the mines by K. D. White, of the Cooperative Mining Investigations, and other members of the Geological Survey.

OGLESBY COAL COMPANY

Section 1, face, 9th left off convict entry.—Thickness, 46 inches. Bed is about same in quality throughout except near bottom where it is softer and breaks into finer coal; the bed is only slightly banded. Coal is bright, medium hard, and the fracture sub-conchoidal; texture is uniform. The few mother coal partings are compact and soil the fingers but slightly; coal contains considerable sulphur mostly in bands, although balls are present irregularly; near the top of the bed the sulphur is mixed with carbonaceous dirt bands; sulphur occurs also mixed with calcite in veins roughly perpendicular to the bedding.

Section 2, 10th right, off convict entry.—Thickness 39 inches. Coal much purer than in section 1; very little sulphur; calcite in thin plates, with only a little sulphur.

Section 3, face main south entry.—Thickness 42 inches. Bed solid, not banded; makes large blocks. Coal hard and bright. There is sulphur mixed with the mother coal and carbonaceous dirt in lenses and bands throughout; calcite in veins exists in small amounts, and little or no sulphur is associated with it; mother coal partings are fairly sooty.

Two graphic sections of the coal in this mine are shown in figure 15 (Nos. 1 and 13).

LA SALLE COUNTY CARBON COAL CO., LA SALLE SHAFT

Section 1, 15th northeast, Rockwell.—Coal hard, bright, having hackley fracture and smooth texture. Contains some sulphur that is separated from the coal with difficulty.

Section 2, 14th east, 1st left north.—Thickness 41 inches. A portion of the bed has a banded appearance but the remainder presents a solid face; there is no regularity in the position of the banded portion. Coal very bright, hard, brittle, clean, save for sulphur bands and balls; sheets of calcite and sulphur along the cleavage planes give the coal a whitish appearance; the occurrence of the calcite is irregular; a band of sulphur balls which is persistent at this place, lies 21 inches from the top of the coal.

Graphic sections 10, 11 and 12, figure 15, are drawn from detailed measurements of the coal in this mine.

ILLINOIS ZINC COMPANY, BLACK HOLLOW MINE

Section 1, face, main slope.—Thickness 44 inches. The coal is solid, is not banded, and has about the same character from top to bottom. Coal strikes N. 17° W. and dips 30° southwest. Coal hard, bright, and brittle. Large amount of calcite and sulphur along faces; veins of calcite and sulphur traverse the bed at right angles to the dip; bands of sulphur balls lie 16 and 18 inches from the bottom of the bed, but are in many places absent; bottom of coal is very clean.

SPRING VALLEY COAL CO., MINE NO. 5, DALZELL SHAFT

General description.—Maximum thickness 48 inches; minimum 28 inches; average 39 inches. The coal occurs in two benches, the division being 13 inches from the top of the seam. The coal is harder at the top, is bright, blocky, with smooth texture. A clay ½ to 4 inches thick containing bands of pyrite, lies between the draw slate and the coal; this is absent when the coal is overlain by black slate; it is "frozen" to the coal and brings the draw slate with the coal. Veinlets of calcite and sulphur occur irregularly.

Section 1, main east entry.—Thickness 37 inches. Top 13 inches bright, clean, solid, blocky, and not banded; lower coal slightly banded. Top 13 inches contains very little mother coal and small amount of calcite; mother coal parting 13 inches from top; bands of mother coal are numerous in lower part of bed and in places are filled with sulphur; sulphur band 6 inches from bottom is fairly persistent. Cleat is poorly developed.

Section 2, 2d left, off main east entry.—Thickness 41 inches. Coal generally similar to that observed at section 1. Partings 13 inches from the top and 6 inches from the bottom; middle of the bed has several bands of sulphur and mother coal; a few vertical streaks of sulphur are present.

For a graphic section of the coal in this mine see figure 15, No 15.

ST. PAUL COAL CO., CHERRY MINE, CHERRY.

Coal varies from 52 inches to 24 inches, with an average thickness of 42 inches.

Section 1, main west entry.—Thickness 43 inches. Upper foot of the coal solid, not banded. Parting lies 13 inches from the top; 16 inches from the top occurs a mixture of 4 inches of sulphur and coal, which is discarded in mining; the lower 2 feet of the bed contains calcite plates, though not in large amount.

For a graphic section of the coal in the mine, see figure 15, No. 14.

MARQUETTE THIRD VEIN COAL CO., MARQUETTE MINE, MARQUETTE

Maximum thickness 48 inches; minimum, 38 inches; average 40 inches.

Section 1, face, 7th west, south entry.—The coal is hard and brittle, and cleat is poorly developed. There are a few layers of bone and mother coal; the sulphur occurs in balls, few in number, easily separated from the coal; calcite is found in vertical veins about 1 inch thick and in small amounts along the faces.

WENONA COAL CO., WENONA

Maximum thickness 48 inches; minimum, 38 inches; average 40 inches.

Section 1, face, straight west entry.—Thickness 45 inches. Coal is hard, solid toward the top, slightly banded near the bottom; the edges of the fractures are sharp. Cleat north 47° west is strongly developed. There is considerable mother coal near the bottom, making that part of the bed rather soft; sulphur exists in small balls and calcite lies along cleavage planes.

Section 2, 27th north, 3d east entry.—Thickness 38 inches. The coal is solid, hard, and brittle; the fracture is slightly conchoidal; cleat is poorly developed. Calcite occurs in veins throughout the bed.

WILMINGTON STAR COAL CO., MINE NO. 7, COAL CITY

Section 1, face, 7th west, south entry.—The coal is hard and brittle, and cleat the top coal is harder than the bottom and in most places is brighter. The cleat is poorly and irregularly developed. The coal shoots into good-sized blocks. There is very little calcite present; near the middle of the bed there is a band of mother coal and sulphur in parts of the mine.

CHICAGO, WILMINGTON, AND VERMILION COAL CO., MINE NO. 1, SOUTH WILMINGTON

Maximum thickness 39 inches; minimum 36 inches; average 37 inches.

Section 1, face, main southeast heading.—Thickness 38 inches. Coal hard and brittle, fracture slightly conchoidal; the bed is solid and not laminated; the coal is in general similar from top to bottom. Impurities are mother coal in streaks and bands, sulphur in balls and lenses; the sulphur "freezes" to the coal but is separated in mining. The middle 8 inches of the bed 13 inches from the top contains the most of the impurities and seems to be a little softer than the remainder.

TOLUCA COAL CO., TOLUCA

Maximum thickness 40 inches; minimum 26 inches; average 34 inches.

Section 1, face, main west entry.—Thickness 35 inches. Coal brittle, cleavage irregular; the coal is slightly banded near the bottom. The top 6 inches of coal is especially bright. Calcite occurs in small amount in vertical veins about 12 inches apart, and in thin plates throughout the bed; sulphur occurs

in irregularly scattered lenses in the seam with the long axes parallel to the bed; there are a few lenses of "jack."

Section 2, room 5, 1st left, second east, off second south entry.—Thickness 33 inches. The coal is similar to that at the other localities, but contains more sulphur. The top 3 inches of coal is as a rule much brighter than the rest of the bed.

The observations that precede are based on the field work of 1912 by the Cooperative Investigation and include only the mines chosen by this Bureau. Observations previously made are less full, but usually describe the coal with considerable detail. Several descriptions of the coal in mines not included among those on the list of Cooperative Investigation follow herewith.

ILLINOIS THIRD VEIN COAL CO., LADD MINE, LADD

Section in room 1, 1st west main, 1st south of 1st left entry

	Thickness *Inches*	Depth *Inches*
Coal	6	6
Mother coal and sulphur	¼	6¼
Coal	6½	13¾
Mother coal	¼	14
Coal	5½	19½
Mother coal	¼	19¾
Coal	12	31¾
Sulphur	1	32¾
Coal	7	39¾

The sulphur band varies in thickness but usually occurs at about the same horizon. A few scattered lenses of sulphur were also noted. The two upper coals were brighter and harder than the lower seams.

JAMES CAHILL, CAHILL MINE, PERU

Section in 1st north, 2d west, straight north

	Thickness *Inches*	Depth *Inches*
Coal	32	32
Sulphur and bone	½ or less	32½
Coal	9	41½

The sulphur and bone is not persistent. There are very few places in the mine without a sulphur streak in some part of the seam.

MINONK COAL CO., MINONK

Section 1 in 15th west entry, 1000 yards out

	Thickness *Inches*	Depth *Inches*
Coal	4	4
Sulphur	½	4½
Coal	30	34½

Section 2 in the right off 2d right off the 10th west entry

	Thickness *Inches*	Depth *Inches*
Coal with transverse sulphur vein....................	17½	17½
Coal	11	28½
Shale band	½	29
Coal	4	33

The sulphur band in section 1 is not persistent. The lower coal has a ½-inch soft streak in the middle.

CHICAGO, WILMINGTON AND VERMILION COAL CO., MINE NO. 2, STREATOR

Section in end, left-hand cross road off straight north entry about 1300 feet northwest of shaft

	Thickness *Inches*	Depth *Inches*
Coal	6	6
Sulphur	⅛	6⅛
Coal	30	36⅛

The foregoing section and descriptions are sufficiently scattered to include every part of the Longwall District. The coal is similar in many respects in regard to hardness and brittleness, distribution of sulphur lenses and calcite plates. The quantity and position of the impurities differ from place to place. In a few mines the coal occurs in benches and in some places persistent impurities are present over considerable areas. It is hoped that these sections together with the general descriptions that preceded them will give an adequate idea of the physical character of coal No. 2 in the Longwall District.

ROOF OF COAL NO. 2

The typical roof of No. 2 coal is a gray shale or soapstone. This is in places replaced by black, fissile shale or "slate" which is 3 feet thick and contains large ironstone concretions or niggerheads. This black shale ordinarily lies 12 to 18 feet above coal No. 2 over large areas, but the interval is not a constant one, the shale in many places rolling down toward or even on to the coal.

East of the fold the gray shale becomes thicker, and the black shale thinner. Between Morris and Coal City especially in the vicinity of Mazon Creek, the shale over the coal contains many fossiliferous concretions. The shale here is sandy, not the typical soapstone of the La Salle region. In the vicinity of Cardiff a thick coal bed occupies part of the section of the soapstone, being separated from No. 2 coal by but a few feet of the shale.

Draw slate above coal No. 2 is not common, but is present in a number of mines.

The following summary presents the data relative to the roof conditions in a number of mines in the Longwall District as observed members of the Survey.

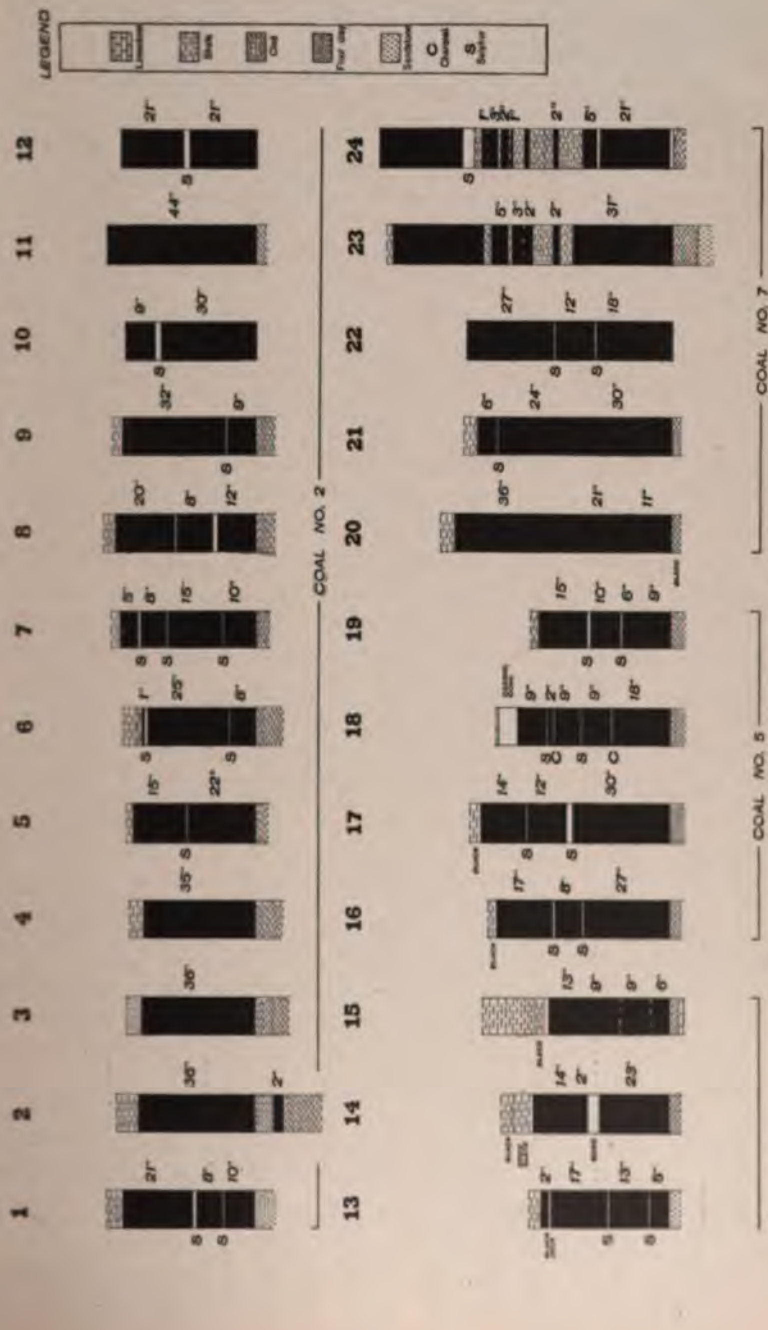

FIG. 15. Graphic sections of coal beds in the Longwall District

Table 1.—*Summary of roof conditions of coal No. 2 in various mines in the Longwall District*

Company	Mine	Cap rock		Height above coal	Immediate roof		Draw slate
		Character	Thickness		Character	Thickness	
			Feet	*Feet*		*Feet*	
Oglesby Coal Co.	Oglesby	Black shale	4 to 5		Gray shale	0 to 18	None
La Salle County Carbon Coal Co.	La Salle	Black shale	3 to 5	0 to 50	Gray shale Average	0 to 50 15 to 20	Gray shale
Spring Valley Coal Co.	Dalzell No. 5	Black shale	3 to 15	0 to 30	Gray shale	0 to 30	Gray shale
Marquette Third Vein Coal Co.		Black shale	2 to 4	5 to 10	Gray shale	5 to 10	None
Illinois Zinc Co.	Black Hollow	Black shale	1	0 to 18	Gray shale (average)	16 to 17	Gray shale
St. Paul Coal Co.	Cherry	Black shale	1⅔		Gray shale		Gray shale
Wenona Coal Co.	Wenona	Black shale	4 to 6	0 to 11	Gray shale	0 to 11	None
Toluca Coal Co.	No. 1 & No. 2	Unknown			Gray shale	20	Gray shale
Wilmington Star Mining Co.	No. 7	Shaly sandstone	50		Sandy shale		None
Chicago, Wilmington & Vermilion Coal Co.	No. 1	Black shale		20	Gray shale	20	Gray shale
Illinois Third Vein Coal Co.	Ladd	Black shale	5	18	Gray shale	18	Gray shale
Braidwood Wilmington Mfg. Co.					Hard shale		
Big Four Wilmington Coal Co.					Shale and sandstone		
Rutland Coal Co.					Soapstone		
Minonk Coal Co.					Soapstone, gray to black		

Additional and more detailed observations on the character of the roof of coal No. 2 as noted in a few of the mines follow.

OGLESBY COAL CO., OGLESBY MINE

General description.—The normal gray shale exists over all but about 5 per cent of the mine. Where the gray shale lenses out, it is in most places accompanied by a "roll" which cuts down the thickness of the coal. Where the roll begins the parting is not sharp, but stringers of coal about 2 inches thick occur, mixed with shale, and stringers of coal run into the shale. Toward the center of the roll the contact between the coal and the roof is sharp. It is reported that where the black shale forms the roof the temperature is always higher and the black shale itself is reported to be warm.

Face, 9th left off convict entry.—The roof is a gray shale full of slip surfaces and slickensides. The shale is bedded, and slickensided horizontally along bedding planes. At the locality of observation there is 3 inches of draw slate and a layer of coal ½ inch thick between the shale and the coal. The contact between the coal stringer and the coal bed is slickensided. The line of contact between the coal and shale is very sharp.

10th right off convict entry.—The roof is a gray shale with sandy sulphurous nodules in elongated, thin lenses parallel to the bedding. The shale is slickensided horizontally along the bedding planes. The line of contact with the coal is sharp.

MARQUETTE THIRD VEIN COAL CO., MARQUETTE MINE

In this mine the gray, shale roof is 9 feet thick. Above the gray shale is black "slate". The roof shale is dark gray in color, contains no sand, and is separated into benches.

ST. PAUL COAL CO., CHERRY MINE

The roof is a gray shale or "soapstone", rather soft, and contains very little sand and black shale; it is bedded by distinct partings. The black shale is present in rather irregular, long, thin pencils; forms lenses and commonly cuts out about a foot of coal where the lens starts. The black shale contains pyrite balls.

WENONA COAL CO., WENONA

The roof is commonly a gray shale containing variable amounts of sand. In a small area it is black "slate" with limy concretions. The shale in parts of the mine is massive, not bedded, and nearly free from sand (soapstone); in other parts of the mine it is interbedded and streaked with white sand. Many sulphur balls are distributed irregularly in the shale.

TOLUCA COAL CO., TOLUCA NO. 1 AND 2

The roof, a gray shale, is in no place less than 10 feet thick. The shale is bedded and contains slickensided partings called "smooths". In brushing the roof an effort is made to brush to a "smooth". The shale contains ironstone concretions, ½ to 1 inch long in bands parallel to the bedding.

CHICAGO, WILMINGTON AND VERMILION COAL CO., MINE NO. 1

The roof is a laminated, light-gray shale. Ironstone nodules occur in bands parallel to the bedding. These nodules are lenticular, the longer axis being 2 inches or less. The layers are smooth along the bedding planes

The roof of No. 2 coal is excellently adapted to the longwall method of mining. By undercutting the coal in the floor clay or if the fire clay is too sandy in the lower few inches of the coal, sufficient leverage is applied by the settling roof shale to break down the coal during the night. Because of the method of mining, the use of explosives in the No. 2 coal is very uncommon and never desirable. In some mines the clay shows a tendency to fall as high as the black "slate" even along the roads.

The gray shale, as has been noted in some of the observations, contains rather numerous nodules which have a rather high percentage of iron sulphide. Upon exposure to the air in the waste piles with dirty coal and refuse the sulphide oxidizes and burns, the light blue color of the flame being visible only at night. Eventually the gray waste pile changes to a reddish color as a result of the oxidation, and patches of yellow sulphurous material are found scattered over the heaps where the material is relatively fresh. The shale as it goes to pieces at the surface breaks up more or less concentrically, possibly around the small concretions.

FIG. 16. The rock dump at mine No. 3, Spring Valley Coal Co., a characteristic scene in the Longwall District.

The roof shale has been put to very little use within the district, although it has been tested at some mines. Some is being used by one of the brick plants near La Salle, but only incidentally. The shale has also been shipped from Coal City and Minonk. Extensive collection of samples was made by the Cooperative Mining Investigation, and a bulletin will soon be issued in cooperation with the Ceramics department of the University of Illinois. The burned shale from waste piles has been used somewhat near La Salle as road ballast. It makes an excellent, smooth road while it lasts but apparently is not very durable. The rock dump such as is shown in figure 16 is one of the characteristic features of the landscape in the Longwall District.

FLOOR OF COAL NO. 2

Most of the material underlying coal No. 2 is a dark gray clay. West of the anticline this clay is thin and in places absent, the coal resting directly on a sandstone or sandy shale, which makes undercutting difficult. Where no clay is present the coal is commonly cut rather than the material below.

East of the anticline and parallel with it the underclay thickens very considerably, so that clay 20 to 25 feet thick is known in places. Two stratigraphic horizons are possibly represented in the underclay where it is thick, the true underclay of coal No. 2 not being over 4 or 5 feet in thickness (see discussion Chapter I). This thick clay is of considerable importance at various places in the district as a source of fire clay and pottery clay.

Along the anticline where the water has rather easy access to the thick clay, the floor in the mines heaves very badly. This is true in the Black Hollow mine of the Illinois Zinc Co., and is also true in the Rockwell mine of the La Salle County Carbon Coal Co. Great difficulty is encountered in keeping the rooms and entries open because of the rapidity with which the clay squeezes into them. In a number of places in the Black Hollow mine the present road bed is above the original timbering.

The observations on the character of the floor in various mines in the district are given in brief form below.

OGLESBY COAL CO., OGLESBY MINE

The floor is fire clay of unknown thickness. It varies in the quantity of contained sand, in the tendency to heave, and in hardness. Where soft and free from sand the clay heaves badly, where sandy it heaves but slightly.

LA SALLE COUNTY CARBON COAL CO., LA SALLE MINE

The fire clay has a maximum thickness of at least 20 feet and is of uniform character. It is dark and hard, with breaking faces smoothed. Below the clay a hard, sandy shale is reported, which in places cuts out the clay. A few ironstone concretions are reported to be scattered through the clay. Undercut about 8 inches.

ILLINOIS ZINC CO., BLACK HOLLOW MINE

Fire clay floor is reported 12 to 15 inches thick and of uniform character. The floor is reported to heave very badly whether wet or dry. During a night it is reported to swell so badly that roads have to be graded to pass loads. It will completely close an entry in twelve hours.

SPRING VALLEY COAL CO., DALZELL MINE NO. 5

The floor is a light gray, micaceous, clayey sandstone grading into clay. Its thickness is 6 to 12 inches and averages 6 to 8 inches. It contains a few root impressions. The miners undercut generally about 12 inches of the bottom, sometimes as much as 24 inches.

Clay Co., Streator.

ST. PAUL COAL CO., CHERRY MINE

The floor is a dark gray shale or clay, with plant impressions. The thickness varies to a maximum of 15 inches, averaging 8 inches. The clay varies in the amount of sand contained. Sandstone is reported to lie 4 feet below the coal. The undercutting is generally in the 10 inches below the coal, but there is some mining in the coal.

MARQUETTE THIRD VEIN COAL CO., MARQUETTE MINE

The floor is a clay 3 to 5 feet thick. The clay shells off and does not have to be shot. The undercutting is in the clay to the first parting, which varies from 8 inches to 3 feet below the coal. The clay above the parting heaves, but that below is solid. Sandstone is reported below the clay; and boulders at a depth of 5 feet.

WENONA COAL CO., WENONA MINE

The floor clay averages from 3 to 9 inches in thickness. The undercutting is in the upper bench of clay, which thickens locally to 12 inches. The lower bench is harder and more sandy, and is not mined. Where the upper bench lenses out the mining is in the coal.

TOLUCA COAL CO., MINES NO. 1 AND 2

The floor is clay at least 3 feet thick. It is of uniform character and heaves slightly.

WILMINGTON STAR MINING CO., MINE NO. 7

The floor is fire clay averaging about 7 feet in thickness, is uniform in character, and heaves somewhat. Undercutting is done in the clay to a depth of 18 to 24 inches. Shale is reported to underlie the clay.

CHICAGO, WILMINGTON & VERMILION COAL CO., MINE NO. 1

The floor is a fire clay averaging about 3 feet in thickness. It is fairly uniform in character. The clay is dark gray at the top, becoming lighter toward the bottom. Near the top it contains considerable carbon and a small amount of root remains. The clay heaves considerably in the air and very badly when wet. The undercutting has an average thickness of 8 to 9 inches, but varies up to 9 inches.

GRAY AND JONES COAL CO., SENECA MINE

The floor is a thick fire clay which heaves when wet. There is at least 12 feet of this material present, but the bed has not been penetrated in the mine. The clay is hard and gray but becomes lighter with depth.

STREATOR CLAY MANUFACTURING COMPANY

At the clay mine in the floor clay of coal No. 2 the clay is 14 feet thick and rests on a 5-foot bed of sandstone.

IRREGULARITIES IN COAL NO. 2

No. 2 coal is very regular in character and thickness over large areas. The character of the bed varies but little within any field, but there is some difference from field to field. Variations in the impurities have already been described at some length. The few structural

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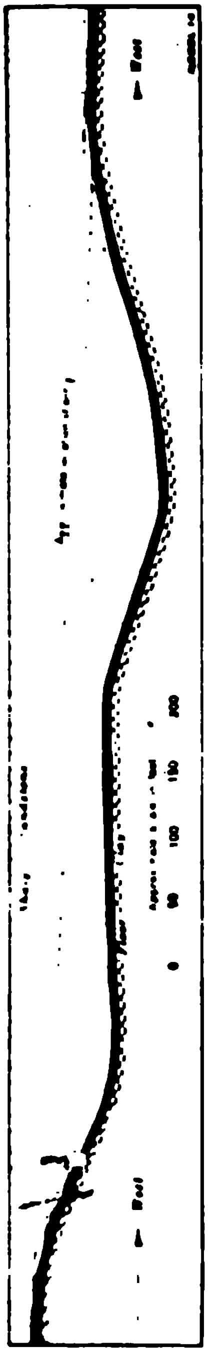


Fig. 17. Syncline in mine No. 7, Wilmington Star Mining Co.

irregularities are interesting, but are not especially important as factors affecting the mining of the coal over the field as a whole. These minor irregularities are small folds and faults or unusual depressions or elevations in the coal bed, and are too broad apparently to be due to folding. In order to give an idea of the lay of the coal in a local area, a contour map of part of the Ladd mine prepared by Mr. F. D. Chadwick, engineer of the Spring Valley Coal Co., is presented in Plate VI. The slight unevenness that is shown presents no great difficulties in mining as long as there is no large quantity of water. Almost any stratum of the "Coal Measures" would be found to vary as much in altitude in an area of the same size.

Possibly the most significant example of variation in the elevation of the coal bed within a short distance, aside from the LaSalle anticline, is found in the Coal City field. This field is especially characterized by the unevenness of the floor. Some indication of this appears in the contour map of the coal (Plate I). The accompanying sketch (fig. 17) is a copy of one made in the field by Mr. K. D. White to illustrate the conditions in mine No. 7 of the Wilmington Star Mining Co. The shaft was sunk near the trough of a wide basin, where the coal was about 50 feet lower than on either side. After the coal was removed from the trough an entry was driven at the level of the shaft bottom toward the coal on either side. The position of this trough is only roughly indicated on the structure contour map by the depression occupied by the Coal City group of mines.

The variations in the position of the coal along the anticline have already been described.

Faults are not large or common, though small ones have been observed. The largest that have been noted are along the anticline in

the Oglesby and Black Hollow mines. One of the most interesting was seen on the east side of the Oglesby mine. A thrust-fault plane cuts the coal at a very low angle, and as a result of a movement in an almost horizontal direction the coal is practically doubled in thickness for a distance of 15 to 20 feet. Apparently the fault plane varies considerably in amount of dip, as later observations by Mr. White indicate a dip of about 45 degrees. The accompanying sketch (fig. 18) drawn by Mr. White shows the condition where he observed the fault.

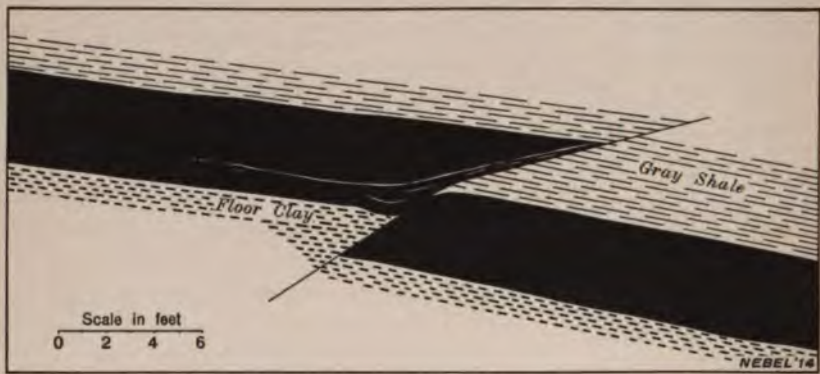
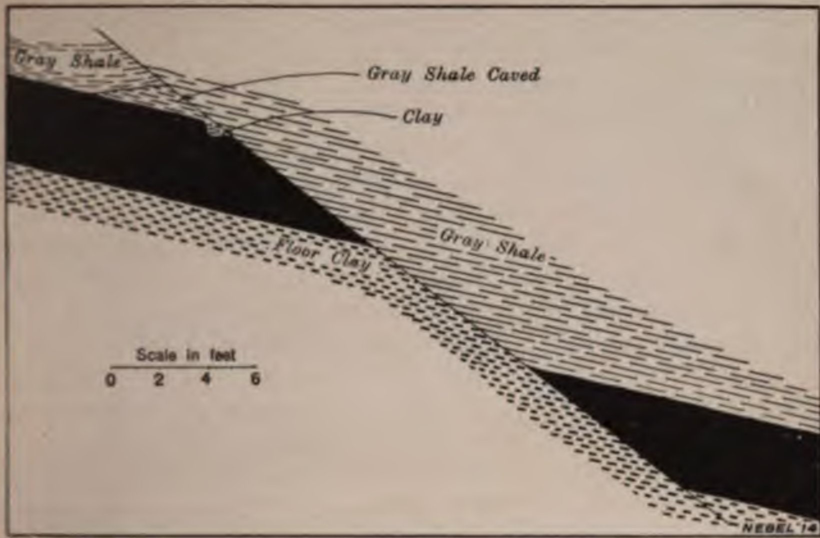


FIG. 18. Thrust fault in the Oglesby mine

In the Black Hollow mine which follows down the west limb of the fold, at least two faulted zones are present. In one of these the fault plane dips toward the west and in the other about at right angles to it. A sketch of the faults is shown in figure 19, *a* and *b*.

Such faults as are found along the anticline are not common over the area as a whole. A few small faults have been noted however in areas not immediately adjacent to the fold. For example, in mine No. 5 of the Spring Valley Coal Co. at Dalzell the coal has been rather intricately broken by a compound fault, the result of which is a normal fault having a throw of about 3 feet. A sketch of this structure is shown in figure 20. Small faults have been noted in the La Salle shaft of the La Salle County Carbon Coal Co. in mine No. 7, Wilmington Star Mining Co. in mine No. 7, Chicago, Wilmington & Vermilion Coal Co., and in the mine at Wenona. In no case was the throw or vertical displacement sufficient to remove the coal entirely from the face. It is not unlikely that most of the mines in the district have small faults of the character described, though our attention has not been directly called to them.

Irregularities known as *rolls* are in some places faults or faults in part, and in other places a replacement of the upper part of the



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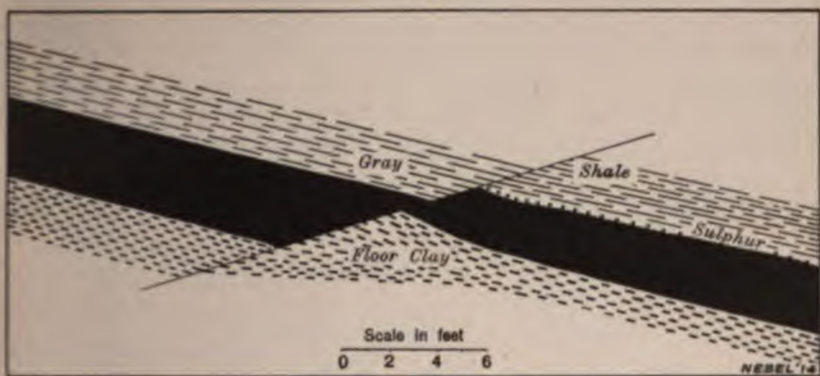

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B. Fig. 19. Normal faults in Black Hollow mine

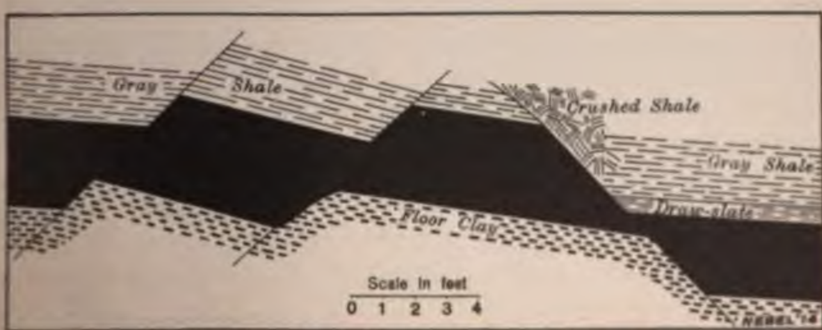

Fig. 20. Step fault in Dalzell shaft, Spring Valley Coal Co.

coal by clay or shale, the roof apparently rolling down into the coal. Such rolls are common, though not sufficiently common to present any great obstacle to mining. The miners' term "fault" would probably include any irregularities where the coal becomes thinner, or is replaced by clay or shale, or is displaced along a fracture line. It is a term that is considerably broader than the geologist's *fault,* which refers only to a *displacement along a line of fracture.*

In parts of the Black Hollow mine, in the clay pits south of Starved Rock Park, and in Bottomly's country bank on the Vermilion River below Lowell, altogether occurring from place to place over 15 to 20 square miles along the anticline and east of it, large, calcareous, boulder-like masses of rock lie in the coal bed, and in some places entirely eliminate the coal. The material of which the boulders are composed seems to be a mixed-up mass of calcareous and carbonaceous rock, which in some places is also somewhat sandy. The origin of the rock is not well understood, but the general impression gained after seeing six of the boulders is that at the time of deposition the organic debris of the coal was mixed with calcareous material, resulting in a rock that is neither coal nor true limestone. Both calcareous and organic matter seem to penetrate the whole rock rather than to occur as fragments. It does not appear, therefore, as has been suggested, that the boulders are residuals of earlier erosion, like the Trenton limestone boulders resting on the St. Peter sandstone below, nor do they appear to have been rolled into the coal after its accumulation. Why they are localized along the fold is not clear, and their distribution may have no relation to the anticline.

In a number of mines west of the fold where the black, fissile shale rests on the coal bed, the seam in most places is reported to be thinner and harder than elsewhere, as though the bed had been more compressed below the harder shale.

Coal No. 5

DISTRIBUTION AND THICKNESS

The area underlain by coal No. 5 lies west of the La Salle anticline. Strata at this horizon outcrop along the sides of the pre-glacial valleys forming the Illinois-Rock system between Princeton and Seatonville and east of the present Illinois valley south of the bend. The distribution of the coal as determined mainly from drill holes and mines, is shown in Plate VII. The holes where the coal is missing are indicated by small circles. Of the three important coals of the district, No. 5 occupies the least area. As has been suggested, this is largely because of the absence of the bed east of the fold, but also

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because the coal is not everywhere present west of the anticline. The irregular distribution of the coal may be due to lack of deposition or to erosion subsequent to deposition. In places the sandstone or sandy shale which lies in the section above coal No. 5 is continuous with the sandstone below the coal and cuts out the coal altogether. The bed appears to occur in more or less trough-like bodies between areas of sandstone. For example, in T. 31 N., R. 1 W. in the southeast corner of Putnam Co. a tongue-shaped area of this coal extends from sec. 3 to sec. 14 in a southeast direction. The drill holes on either side show sandstone or sandy shale at the same horizon. The isolated character of the bodies of this coal is well shown by the small body of coal that occurs in a small trough in the sandstone along the Vermilion River about a mile below Lowell in sec. 8, T. 32 N., R. 2 E. The coal bed has been exposed by the river and its lenticular character and relation to the adjacent sandstone is clear.

There seems to be an area running southward through the district about along the line of the Third Principal Meridian as a center in which there is a large number of holes showing coal No. 5 to be absent, and the mines also have found the coal unworkable (see Plate VII). This area possibly swings more to the east, north of the Illinois River, but the exact extent is not known very definitely. This coal was formerly worked at the Cherry mine and unsatisfactory conditions were encountered toward the east side of the mine; similarly in the M. & H. mine the coal is found difficult to handle toward the west. It is reported that the upper bed in the mine of the Cahill Coal Co. was not workable at least to the north. It seems probable therefore that there is considerable area where the bed is of unsatisfactory character between La Salle and Spring Valley.

In the northern part of the La Salle-Minonk field the No. 5 coal has been mined at a number of places, but is worked at present only by the Matthiessen and Hegeler Zinc Co. at La Salle. The St. Paul Coal Co. mined this coal at Cherry before the disaster. Our best observations of the characteristics of this coal are from the M. & H. mine. This is supplemented by information from drill records and observations at Cherry.

In the M. & H. mine the coal varies in thickness from 24 to 54 inches and has an average of 48 inches. (See figure 15, Nos. 16, 17, and 18). Irregularities or impurities are not continuous, but balls and lenticular bands of sulphur as much as 1 inch in thickness may be seen in small amount. The coal is medium hard, bright, blocky, and possesses a banded texture.

"Horsebacks" and rolls of clay and sandy material form the more common impurities. At irregular intervals and apparently without

much association, cracks due probably to shrinkage penetrate the coal bed from top to bottom. These cracks under normal conditions are filled with gray clay in fragmentary form and traversed with slickensided surfaces. Where the coal is otherwise normal these "horsebacks" do not disturb the coal beyond their immediate edges which are relatively sharp. They have a width varying from a few inches to about a foot, and a horizontal extension of at least the width of a room. In most places they have little effect on mining. The clay seems to have been squeezed in from below, as it resembles the floor clay in character. The fissures extend into the roof but are not known to continue into the floor.

It is thought that the occurrence of these cracks in this thick bed, and not in the thinner No. 2 coal, arises from the greater irregularities in thickness within short distances, a more plastic floor which squeezes into fissures, a greater variability in the roof which changes from more or less plastic shale to hard sandstone or even limestone, and from a greater general thickness. Strains resulting from the different degrees of compressibility upon solidification of adjacent strata might be sufficient to cause fissuring. The correlation of this coal with the No. 5 or Springfield coal is based partly upon the presence of these "horsebacks."

A peculiar condition of the roof and coal known locally as "white top", exists on the west side of the M. & H. mine (fig. 21) on the east side of the Cherry mine (middle bed), and, according to report, in the Cahill mine. At Cherry this consists of a white to gray sandstone or sandy, gray shale which replaces the usual gray and black shale of the roof and permeates the coal down to a band of clay found about 14 inches from the floor. Large pieces of white sandstone are found scattered through the bed so that the whole resembles a conglomerate. Slickenside surfaces are quite common throughout the "white-top" areas, and the roof is commonly rough and broken, so that it is very difficult to keep the roads clear. The impurities at some of these places exceed one-half of the total thickness of the bed, and render the coal worthless. Fig. 21 shows an occurrence of "white top."

A satisfactory explanation of the "white top" has not been reached. It is believed however that the interruption in the bed arises from some cause associated with the interruption in deposition, or even erosion after the deposition, of coal No. 5. The shifting of sand and silt from the surface into partly weathered coal would possibly result in a more or less intimate mixture of coal and sand such as characterizes "white top." None of the mines have been extended very far into these areas, but have skirted the edges, and felt out the boundaries. As a result it is not known whether the presence of "white top" is an indication

of the entire failure of the coal in adjacent areas. In the old reports Freeman states that the "middle vein" is absent through Peru and northward. If the statement is correct, the occurrence of "white top" seems to be a condition bordering the productive area.

FIG. 21. "White top" in coal No. 5 in the northwest side of the M. and H. mine, La Salle.

Practically all the white shown in the picture is sandstone, even the thin seams in the roof. The roof here is a black shale and is penetrated by these thin lenses of sand that seem to lie parallel with the bedding. The large mass of white in the centre is a sandstone "horseback" which in many respects resembles the clay "horsebacks" found elsewhere in the mine and in the upper coal (see figure 22). It will be noted that the contact between the coal and the sand is sharp, even where points of coal extend down into the sand. Thin seams of sandstone extend into the coal on the right, whereas to the left the material is a mass of broken fragments of coal, arranged roughly parallel with the bedding, and much interrupted by *sand*. Slickensided surfaces are common.

The information regarding coal No. 5 elsewhere in the district is largely obtained from records of drill holes and shafts. In regard to the coal bed itself a record tells little of value except its depth and thickness. The depth at the different localities can be determined roughly from the structure contour map. The records show a great

variation in thickness to a maximum of 75 inches. Out of 66 records the thicknesses are distributed about as follows:

Bore hole records showing thickness of coal No. 5

No. of records	Variation in thickness *Inches*
6	2—10
7	11—20
7	21—30
9	31—40
13	41—50
14	51—60
5	61—70
5	71—75

Within the area in which these holes were drilled there are several holes that showed no coal, as is indicated on the map (Pl. V).

The interval between coal No. 2 and coal No. 5 varies somewhat in different parts of the field. Investigations within the area of the Hennepin quadrangle show a range of interval between the two seams of 152 to 191 feet, or 39 feet, the average being about 180 feet. On the La Salle quadrangle the range of interval was 55 feet, from 150 feet to 205 feet, the interval increasing somewhat from north to south and from east to west. The interval between coal No. 2 and coal No. 5 is greater than the interval between coal No. 2 and coal No. 7 east of the anticline. For the most part, there seems to be no systematic distribution of the variations in interval, closely adjacent holes being almost as likely to show considerable variations as those that are more widely separated.

Table 2 shows the intervals between No. 2, No. 5, and No. 7 coals in a large number of the drill holes and mines of the western part of the Longwall District. The five observations shown at the end of the table are on mines in the Streator region east of the anticline, and the intervals between coals No. 2 and No. 5 are notably less than for the other observations tabulated.

TABLE 2.—*The depth to coals No. 2, No. 5 and No. 7 and the interval between the tops of the beds in certain mines and drill holes in the western part of the Longwall District*

BUREAU COUNTY

ALL IN RANGE EAST

Name or company No.	Location ¼	¼	Sec.	T. N.	R.	Depth to coal No.	Interval: top coal No. 2 to top coal No. 5	Depth to coal No. 5	Interval: top coal No. 5 to top coal No. 7	Depth to coal No. 7	Interval: top coal No. 2 to top coal No. 7
H	SW	NE	34	17	10	474	170	304	..	-E-	...
54	NW	NW	3	17	11	...	...	321	39	282	...
..	SW	SW	15	17	11	427	138	269?	..	-E-	...
22	SW	NW	19	17	11	446	169	277	..	-E-	...
F	SE	NW	3	16	10	467	171	296	..	-E-	...
N	NW	SE	5	16	10	359	...	-M-	..	115	244
L	NW	NW	6	16	10	421	183	238	43	195	226
J	NW	NE	7	16	10	393	179	214	44	170	223
M	SW	SE	7	16	10	378	181	197	..	-E-	...
K	NW	SE	8	16	10	341	186	155	44	111	230
Heathcock	SE	NE	17	16	10	...	...	186	33	153	...
Walton	....	....	17	16	10	...	...	146	51	95	...
R	SE	NE	19	16	10	378	183	195	40	155	223
U	SE	SW	12	16	9	382	194	188	38	150	232
18	....	NW	19	17	11	454	174	280	..	-E-	...
17	SE	NE	20	17	11	414	149	265	..	-E-	...
21	NE	SE	20	17	11	407	143	264	50	214	193
21	SW	SW	24	17	11	444	152	292	43	249	195
8	E½	SW	25	17	11	463	170	293	42	251	212
26	NW	SE	27	17	11	452	158	294	47	247	205
Cherry	SW	NW	27	17	11	480	163	317	36	271	209
2	SW	NW	27	17	11	475	158	317	42	275	200
6	W½	NW	29	17	11	416	154	262	41	221	195
35	S½	SW	30	17	11	440	160	280	44	236	204
51	NE	NE	33	17	11	...	...	305	42	263	...
53	NW	SW	34	17	11	450	165	285	39	246	204
53	NW	SW	34	17	11	439	159	280	41	239	200
28	SW	SE	1	16	11	459	177	282	40	242	217
10	N½	NW	7	16	11	465	178	287	40	247	218
4	N½	SE	8	16	11	424	175	249	36	213	211
9	SE	NE	11	16	11	452	171	281	35	246	206
G	NE	SE	2	16	10	422	168	254	..	-E-	...

TABLE 2.—*Continued*

PUTNAM COUNTY

ALL IN RANGE WEST

Name or company No.	Location ¼	Location ¼	Sec.	T. N.	R.	Depth to coal No. 2	Interval: top coal No. 2 to top coal No. 5	Depth to coal No. 5	Interval: top coal No. 5 to top coal No. 7	Depth to coal No. 7	Interval: top coal No. 2 to top coal No. 7
..	NE	SE	1	32	2	386	185	205?	..	...	...
2	SW	NE	1	31	1	536	...	-M-	..	318	218
11	NE	SW	2	31	1	503	137	366	60	306	197
4	NE	SW	3	31	1	489	...	-M-	..	261	228
3	NE	NW	9	31	1	454	...	-M-	..	227	227
6	NW	SE	10	31	1	485	210	275	24	251	234
10	SW	NE	11	31	1	489	147	342	51	291	198
4	SE	SW	11	31	1	488	...	-M-	..	250	238
3	SE	NW	12	31	1	519	...	-M-	..	301	218
8	NW	SE	14	31	1	497	164	333	47	286	211
7	Near	Center	15	31	1	465	...	-M-	..	240	225
..	NE	NW	2	32	1	528	128	400	50	350	178
6	NW	NW	3	32	1	425	181	244	35	209	216
Granville	NW	NE	8	32	1	457	194	263	35	228	229
10	SW	NE	8	32	1	468	187	271	34	237	231
1	SE	NE	9	32	1	468	173	295	41	254	214
Berry	NE	SW	11	32	1	498	177	321	37	284	214
9	NE	NE	23	32	1	543	...	-M-	..	304	239
8	NE	NW	29	32	1	499	...	-M-	..	304	195
58	NW	NE	29	32	1	507	...	-M-	..	286	221
1	SW	NE	35	32	1	562	...	-M-	..	335	227
3	SW	NW	30	33	1	276	211	65	..	- E-	...

MARSHALL COUNTY

ALL IN RANGE EAST

4	SW	SW	4	29	1	...	...	364	57	307	...
3	SW	NE	5	29	1	499	157	342	54	288	211
2	NE	NE	5	29	1	501	170	331	43	288	213
5	SW	SW	5	29	1	...	...	306	32	274	...
6	W½	NE	7	29	1	...	...	320	36	284	...
7	SW	NW	8	29	1	...	...	314	43	271	...

TABLE 2.—*Concluded*

LA SALLE COUNTY

ALL IN RANGE EAST

Name or company No.	¼	¼	Sec.	T. N.	R.	Depth to coal No. 2	Interval: top coal No. 2 to top coal No. 7	Depth to coal No. 5	Interval: top coal No. 5 to top coal No. 7	Depth to coal No. 7	Interval: top coal No. 2 to top coal No. 7
..	NW	NE	19	34	1	462	216	246	..	-E-	...
4	NW	SE	28	34	1	474	186	288	40	248	226
3	SW	SW	33	34	1	496	...	-M-	..	259	237
5	SW	NW	34	34	1	425	180	245	43	202	223
Caledonia	NW	NW	3	33	1	536	179	357	34	323	213
11	SE	SW	13	33	1	308	191	117	53	64	244
13	Cent	W½	13	33	1	237	172	65	..	-E-	...
7	SW	NW	13	33	1	323	182	141	59	82	241
La Salle	SE	SE	15	33	1	386	153	233	58	175	211
8	SE	SW	13	33	1	320	169	151	..	-E-	...
Oglesby	NE	SW	25	33	1	462	150	312	53	259	203
3?	NE	SE	30	33	1	330	182	148	41	107	223
Cedar Point	W½	SW	4	32	1	541	198	343	43	300	241
4	SE	SE	5	32	1	511	194	317	37	280	231
14	E½	NE	8	32	1	528	196	332	35	297	231
15a	NW	SW	12	32	1	553	191	362	39	323	230
2	NE	NE	12	32	1	464	173	291	59	232	232
3	SE	SE	13	32	1	499	206	293	36	257	242
6	NW	NE	17	32	1	493	180	313	37	276	217
2	SE	NE	26	32	1	559	184	375	40	335	224
13	SE	NE	27	32	1	...	...	380	47	333	...
17	NW	NW	29	32	1	526	...	-M-	..	300	226
4	NE	SW	31	32	2	563	189	374	47	327	236
14	SE	SW	5	31	1	555	123	432?	64	368?	187?
16	SE	SE	14	31	1	583	169	414	50	364	219
15	NW	SW	16	31	1	545	190	355	35	320	225
..	SE	NW	18	31	1	442	174	268	41	227	215
C. W. & V. No. 1	....	....	10	31	3	207	...	-M-	..	92	115
Star C. Co.	....	....	21	31	3	196	...	-M-	..	55	141
C. W. & V. No. 3	SW	SW	24	31	3	216	...	-M-	..	72	144
Peanut No. 2	....	....	35	31	3	181	...	-M-	..	51	130
C. W. & V. No. 2	NW	SW	19	31	4	245	...	-M-	..	103	142

Table 3 shows the interval between coal No. 2 and coal No. 7 for Grundy County and Eastern Livingston County.

E=Eroded.
M=Missing.

THE ROOF OF COAL NO. 5

The roof of coal No. 5 varies from a gray shale to black "slate", sandstone, and locally limestone. The normal roof is a gray sha or a black shale called "slate", the latter containing some "nigge heads" or ironstone concretions. In most places where black slate present, the upper 4 to 8 inches of the coal resembles cannel co Under the normal roof the coal is regular and uninterrupted, but und the sandstone roof the coal is commonly thinner. The sandstone di places the light and dark shale and more or less of the coal, and fu thermore its presence in the roof is generally accompanied by a d pression of the floor. This seems to mean that the additional relati incompressibility of the sand as compared with the adjacent coal a shale made itself felt in the rock underlying the coal, a condition th seems to exist elsewhere in the field. The limestone roof is o locally present.

The roof in the area of "white top" is badly broken and is com posed of white, sandy material like the material in the coal mixed with black shale and fragments of coal. The first sign of the "white top" in the M. & H. mine is a speckled condition of the roof due to the presence in the shale of small spots of the white sand, which develop into stringers of white sandstone. The sand then penetrates farther and farther into the coal bed, though locally with considerable abruptness.

The sandstone which lies above the coal in places is unconformable with the underlying strata, cutting across coal, gray shale, and black "slate." It is quite possible that farther west where the coal is reported missing the sandstone replaces the coal completely. The contact between the sandstone and the shales is sharp, and the roof in places falls to the sandstone.

THE FLOOR OF COAL NO. 5

The floor of coal No. 5 is a gray clay 2 to 4 feet thick in the M. & H. mine and about 1 foot thick at Cherry. The stratum underlying the clay is either a brownish, micaceous, sandy shale or a sandstone.

Coal No. 7

GENERAL DESCRIPTION

Coal No. 7 has been next to coal No. 2 in economic [illegible]rtance in the Longwall District, but is now largely worked known at Streator as the "Streator coal" and in th the "first" or "upper vein." It is being worked Sparland, and in former years was worked at La S

the outcrop north of Illinois River. The M. & H. Coal Co. mine the clay below this coal but have never taken the coal.

The coal underlies approximately 550 square miles of the Longwall District as included in the area of this report and as shown in the map in Plate VIII. The bed is considerably more irregular in its occurrence than coal No. 2, especially along the anticline and eastward as far as Streator. Interruptions in the continuity of the bed also arise from erosion within the limits of the field in the center of the district and on both margins. The coal has been removed in the eastern side of La Salle County and in Livingston County by pre-glacial erosion. The pre-glacial, Rock-Illinois valley gives rise to irregularities on the west side, and the area of the coal to the east is quite uncertain because of the covering of glacial drift. Because of the two sorts of interruptions in the regularity of the coal the estimates of the area underlain by the bed must be regarded as very uncertain. It is certain, however, that the area is less than that underlain by coal No. 2 and greater than that underlain by coal No. 5.

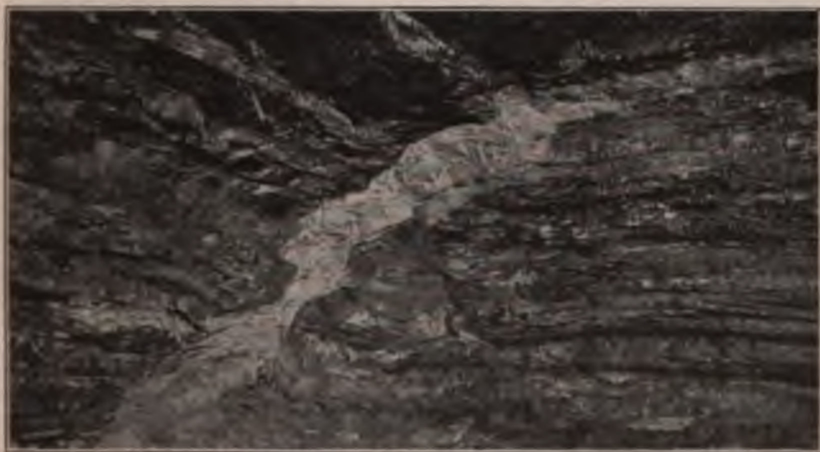

FIG. 22. Coal No. 7 cut by a "horseback" in the M. and H. mine, La Salle.

The thickness of coal No. 7 varies considerably and reaches at least 9 feet in the Kangley-Henanville field at the old Henanville mine. The average thickness of the bed in the Streator field is about 48 inches, not uncommonly increasing to 60 inches or decreasing to 36 inches. In the La Salle region the coal measured 46 inches at the M. & H. clay mine at the only place where it had been entirely penetrated (see figure 22). The drill holes in the La Salle region and in Bureau County show an average thickness of 46 to 48 inches, the extremes being 24 and 60 inches in the same region. The coal was formerly opened at Ladd but was found to be very dirty and was

abandoned. Toward Sparland the upper coal, probably No. 7, varies from 42 to 48 inches. At Toluca thicknesses between 38 and 58 inches were encountered in the various holes. At South Wilmington the coal is from 36 to 48 inches.

The irregularities in the coal No. 7 are probably more common than in coal No. 2 and less than in coal No. 5.

The coal bed has not been seen at La Salle by members of the Survey except at one place in the M. & H. clay mine. The picture shown in figure 22 is a view taken in the mine showing coal No. 7 at a place crossed by a "horseback". The coal seen to the right in the picture is apparently about normal. It is 46 inches thick and has no very distinct partings so far as could be determined.

coal –

– coal

FIG. 23. A broad synclinal depression in coal No. 7 in the pit of the Barr Clay Co., Streator.

COAL NO. 7 IN THE STREATOR FIELD

This coal is best known from its commercial development in the vicinity of Streator. Besides being worked in several mines it has been uncovered by stripping at several clay pits in the same vicinity. The pit of the Barr Clay Co. south of Streator affords one of the best opportunities of viewing the coal that is found in the district. The face of the bed is open for several hundred yards, and the surface has been uncovered for hundreds of square feet, so that exceptional opportunity is given to see the coal both at the face and from the top. A description of the coal as seen in this pit will answer for the entire Streator field.

Section of coal No. 7 in the pit of the Barr Clay Co., Streator

	Thickness *Inches*	Depth *Inches*
Top coal	18	18
Dirt and coal—		
Dirt	1	19
Coal	2	21
Dirt	3	24
Middle Coal	6	30
Dirt and coal	6	36
Bottom coal	12	48

This sequence and the division of the bed into three parts holds over the entire pit, and apparently over the field generally. Each bench is mined separately. Figures 23 to 26 illustrate conditions in this pit.

FIG. 24. A "roll" in the surface of coal No. 7 in the pit of the Barr Clay Co., Streator. The water has partly filled the hole from which the clay has been dug.

The surface of the coal is irregular, there being rather numerous depressions in the surface a foot and a half in depth and 5 or 6 feet in breadth and in a few places as much as 15 to 20 feet long. These depressions are filled with roof clay, and where they occur the top coal is missing. As a rule the "rolls" do not displace any of the middle or lower bench. Figure 24 shows the surface of the coal across one of these "rolls". These rolls are very common but of irregular occurrence.

The physical character of the coal in the different benches is similar. The upper bench is relatively free from bedded impurities. There are a few streaks of mother coal, which seem to contain an unusual amount of sulphur, but they do not make up more than 1 per cent of the total thickness. The upper bench where slightly weathered is banded with dull and bright coal. The bright bands are rarely over ¼ inch thick but they make up possibly one-third of the thickness of the bench. They are free from impurities or laminations, are more brittle than the rest of the bed, and break with conchoidal fracture. The duller coal seems to be laminated throughout, is blocky, and breaks straight across the band.

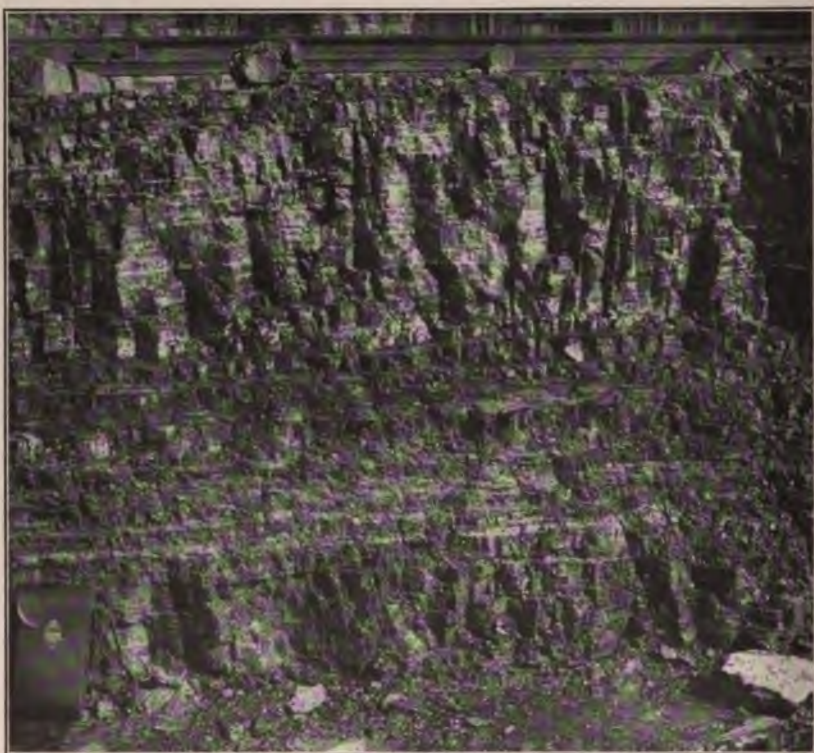

FIG. 25. Coal No. 7 in the pit at the Barr Clay Co., Streator.

The second bench of coal contains dirt, for the most part interbedded as clay streaks which contain much sulphur. The streaks are fairly persistent. The 6 inches of good coal in the middle of the middle bench is constant; above are three coal seams, 1, 1½, and 2 inches thick, interbedded with clay; below there is a succession of interbedded clay and coal seams.

The lowest bench resembles the top in its general characteristics.

Coal No. 7 in the Streator field is very irregular in elevation. Variations in the altitude of the bed as great as 25 feet have been noticed in surface outcrop along Vermilion River. At the Chicago, Indiana, and Southern Railroad bridge the coal rises over the heavy sandstone underlying it, the altitude changing from about the level of the water in the river to 25 or 30 feet above it within a horizontal distance of 100 feet. At this place, at least, the underlying rock does

FIG. 26. Method of digging the three benches of coal in the pit of the Barr Clay Co., Streator.

not partake of the structure of the coal. A smaller variation in level is well exposed in the Barr Clay Co. pit (fig. 21). In about the center of the opening there is a syncline possibly 200 feet across, where the strata in the trough are depressed about 10 feet. The axis of the fold runs about north and south. The overlying strata so far as exposed bend down more or less with the coal, though the fold tends to play out upward. The coal is reported to be a little better in the trough and possibly a little thicker than elsewhere.

Another depression, but on a larger scale, was noted at the position of the Harrison mine in sec. 31, T. 31 N., R. 4 E. The coal bed is reported to be about 40 feet lower at the bottom of the shaft, than a short distance to the south. It will be noted from the structure contour map that the elevation of the coal at the old Acme Coal Co. shaft is about 520 feet above sea level, whereas at the C. W. & V. C. Co. shaft No. 2, and in sec. 1, T. 30 N., R. 4 E., it is about 555 feet. This depression apparently trends northeast-southwest but the area affected is not known.

Additional observations on the coal bed in the Streator field have been made in a few of the mines. Notes by Mr. K. D. White are as follows:

CHICAGO, WILMINGTON, AND VERMILION COAL CO., MINE NO. 3, STREATOR

Section 1, room 72, 3rd right, off 71st east entry

	Thickness *Inches*
Top coal	29
Blacksmith coal, clean and bright	7
Parting of carbonaceous clay	..
Dull coal	3
Parting of mother coal	..
Bottom coal	29

Thickness 68 inches. The entire bed is dull, and is irregularly laminated. The bottom coal is duller than the top, is softer, contains dirt partings, and the bottom 6 inches is bony. About 2 inches from the bottom a sulphur band occurs; calcite is found in fair amount throughout the bed.

Section 2, in room 29 off the 4th right off the main south entry

	Thickness *Inches*
Top coal	32½
Parting of mother coal	..
Splint coal	3½
Mother coal and sulphur	1
Bottom coal	29

The bottom coal is harder than the top. The top coal is fairly bright and soft, having a hackley fracture. Calcite occurs along the cleavage faces; there are lenticular streaks of mother coal; sulphur is present with the mother coal and clay, but only a small amount in balls or lenses; a band of sulphurous mother coal is found in places about 8 inches from the roof. The sulphur in the bed occurs in balls generally, but they are few in number and difficult to separate because they freeze to the coal.

Graphic sections of the coal in this mine are shown in figure 15, Nos. 20, 21, and 22.

Observations by Grout at the No. 2 mine of the Acme Coal Co., which has been abandoned, give the following section of the coal.

ACME COAL CO., MINE NO. 2, STREATOR

Section 1, room 7, 5th left entry

	Thickness Ft.	In.
Hard "soapstone"	10	
Top coal		28
Middle coal—		
Clay		2
Coal		5
Clay		½ to 1
Coal		3
Clay		½
Coal		2
Hard shale		6
Coal		2
Hard shale		12
Bottom coal—		
Coal		1
Coal		30
Shale		8
Sandstone		..

These 6 clay bands extend throughout the mine but do not everywhere make up so large a part of the seam, since each band varies in thickness.

A section, as follows, was measured by Mr. Jon Udden in 1908.

Section 2, in room 10, 5th left off 4th south entry

	Thickness Ft.	In.
Shale	5	
Top coal		29
Sulphur ball 4 by 5 inches		
Middle Coal—		
Clay		2½
Coal		1¾
Clay		¼
Coal		3
Clay		1
Coal		2½
Clay		½
Coal		¼
Clay		3¼
Coal		1¼
Clay		7
Coal		1¼
Clay		7¼
Coal		¼
Clay		1

Bottom coal	21½
Bone coal, soft	1 to 8
Fire clay	3 to 6

Sections No. 23 and 24 of figure 15 are graphic representation of the coal in this mine.

These sections all show the same general characteristics of the bed at the different places where it has been observed. A division into three benches characterizes the coal in this locality, and the middle bench is everywhere dirty.

The roof of coal No. 7 at Streator is a gray siliceous shale 35 or more feet thick, and the floor a gray clay, 2 to 3 feet thick, resting on sandstone. In one mine, at least, black shale lies between the coal and the floor clay. This is probably the same as the bone coal noted at the bottom of the bed in the last section.

COAL NO. 7 IN THE KANGLEY-HENANVILLE FIELD

Northwest of Streator in the Kangley-Henanville field the occurrence of coal No. 7 is somewhat different than in the Streator field. The coal outcrops along Vermilion River above Kangley bridge in sec. 10, where the following section was measured:

Section of the McLeansboro formation on Vermilion River above the Kangley bridge in sec. 10, T. 31 N., R. 3 E.

	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene:				
Glacial drift	20	..	20	..
Pennsylvanian:				
Shale, dark gray............6 to	10	..	30	..
Shale, black, almost fissile, with ironstone concretions	6	..	36	..
Coal No. 7	4	8	40	8
Clay band	..	4	41	..
Coal	1	6	42	6
Fire clay, gray............8 to	15	..	57	6
Shale, black, fissile	3	..	60	6
Shale, black and coal..........1 to	1	6	62	..
Shale, gray micaceous	4	..	66	..
Sandstone, micaceous..........0 to	10	..	76	..
Shale, grayish brown	10+	..	86	..
Coal, cannel ....4 to	..	8	86	8

This association of strata is not constant even in the Kangley-Henanville field. At Henanville coal No. 7 is reported to be 9 feet thick and to be a combination of two beds of coal. The lower bed

may be the equivalent of the 18-inch bench below the clay seam in the coal exposed on the Vermilion, or it may represent one of the lower carbonaceous shales.

The coal at Henanville has already been described (see Chapter I). There is apparently a more or less isolated basin extending northeast-southwest from Henanville toward Kangley, and separated from the Streator field by a sand ridge to the southeast. Probably another ridge separates it from the La Salle field to the west. In this basin the accumulation of peat apparently began earlier than in the other areas, and continued with interruptions until coal No. 7 was deposited. As a result, the Henanville-Kangley basin has below coal No. 7 a number of unusual carbonaceous shales and thin coals. The distribution of the different shales and coals in the basin itself is very irregular.

COAL NO. 7 AT SPARLAND AND TISKILWA

Coal No. 7 in the Sparland field is isolated by erosion from the rest of the district, and belongs in its relationships as much with the Peoria-Springfield District as with the Longwall District. It outcrops along Illinois River bluff and the tributary streams a few feet above the level of the Chicago and Rock Island Railroad tracks at Sparland. The coal is worked at a number of local banks in the vicinity of town and at two shipping mines. Where observed in a local bank about one-half mile west of Sparland it is 42 to 48 inches thick. The roof is a hard, gray shale, containing a few large "niggerheads" or ironstone concretions up to 18 inches in diameter. It resembles the gray shale over the coal at Streator. The coal is much cleaner than that at Streator, sulphur balls and sulphur streaks being uncommon, in which respect the bed resembles the upper bed at La Salle. Where seen at the outcrop, the roof shale is a dark gray shale 2 to 3 feet thick and above it is at least 20 feet of light gray shale carrying small concretions similar to those seen in the shale above No. 7 coal at Streator.

Coal No. 7 has also been observed in the west part of the district at an outcrop along Rocky Run west of Tiskilwa in southern Bureau County. The coal at this place measures 37 inches in one place and 39 inches in another, and is reported to be locally only 24 inches thick. The coal is rather dirty and is traversed at frequent intervals by more or less vertical seams of clay, resembling those in coal No. 5. The roof immediately above the coal is "soapstone" 1 foot or so in thickness. Above the "soapstone" is a dark shale, in places interbedded with streaks of limy ironstone 1 to 2 inches thick, there being 2 such layers in a foot of shale. In other places the limy ironstone is not

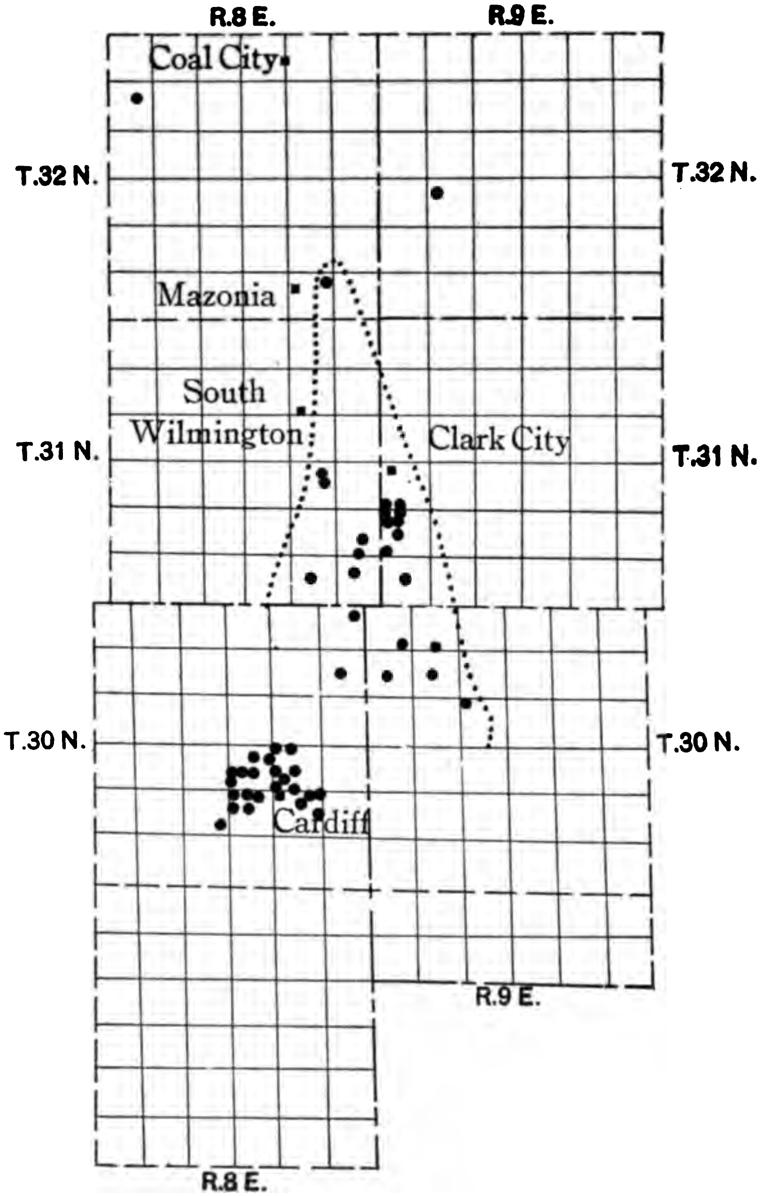

FIG. 27. Approximate outcrop of coal No. 7 in the Coal City, South Wilmington, and Cardiff fields.

present, and the shale becomes darker and more fissile. Four feet of this darker shale may be observed. Above it lies at least 10 feet of gray shale like that at Sparland above the coal. A fine, smooth, and plastic gray fire clay below the coal is reported to be 6 feet thick.

COAL NO. 7 IN THE SOUTH WILMINGTON-CARDIFF FIELD

Coal No. 7 in the South Wilmington-Cardiff area is confined to the southern part of Grundy County near South Wilmington, to the northwest corner of Kankakee County, and to Livingston County, including the Cardiff field. This coal was mined about 20 years ago at Clark City, but unsuccessfully. It is impossible to draw the boundary of the coal bed with much accuracy, because of the uncertainty regarding the depth of the pre-glacial erosion and the thickness of the drift. The approximate area underlain by coal No. 7 in the Cardiff-South Wilmington field is shown in figure 27. Further uncertainty in regard to the area of the coal arises from more or less unsatisfactory correlations of the upper coals in the Cardiff field. In a number of the holes in the center of the field there is a bed of coal 36 to 60 inches thick immediately below the drift that is interpreted as being coal No. 7. If so, the interval between coal No. 2 and coal No. 7 is considerably greater than that farther north in the South Wilmington field.

Table 3 shows the interval between coals No. 2 and No. 7 in the 28 holes in which coal No. 2 was encountered. There is also shown the character of the roof of No. 7 coal and the overlying strata and the floor and the strata below that. This compilation is introduced largely because of the lack of direct observations of the coal since it is not mined in this part of the district.

Following the first two holes described in Table 3 are nine from the Cardiff region in which the interval between the two coal beds is considerably greater than in the others. In the area outside the Cardiff field the average interval is roughly between 50 and 75 feet, but in these holes the interval is 117 to 146 feet. It is also seen that the strata associated with the coal in the Cardiff area are different from those encountered in the other holes in the general region. About halfway between coal No. 7 and coal No. 2 there are two thinner coals, the distribution of which seems to be limited to the area of the Cardiff basin or about the same as the area underlain by the "big vein." (See sections on Plate V.) One of these coal beds is the more persistent within the Cardiff field and may possibly be the real coal No. 7. In Table 4 the particulars of the stratigraphy of this coal are shown similar to those of the higher coal in Table 3.

TABLE 3.—*Stratigraphic data showing the interval between coal No. 2 and coal No. 7, and the character of the strata associated with No. 7 in the South Wilmington-Cardiff field*
(Based upon drill records)

No.	Location			Interval above coal No. 2	Roof			Strata above roof			Floor			Strata below floor		
	Sec.	*T.N*	*RE*	*Feet*		*Ft.*	*In.*		*Ft.*	*In.*		*Ft.*	*In.*		*Ft.*	*In.*
14	1	30	8	62	Black slate	3	3	"Soapstone"	2	1½	Fire clay	8	10	Sandstone	27	7
19	12	30	8	66	"Soapstone"	10	..	Fire clay	3	4	Fire clay	2	5	Sandstone	20	8
2	22	30	8	138	Soft shale	7	..	Drift	..	..	Dark shale	..	2	Sandy shale	18	6
10	22	30	8	117	"Soapstone"	19	..	Rock	3	..	"Soapstone" & fire clay	4	..	Shale	7	..
6	23	30	8	143	Hard rock	..	6	"Soapstone" Drift	2	..	Shale	9	6	Sandstone	10	..
4	23	30	8	134	Dark shale	6	5	Clay shale	7	..	Gray sand shale	1	..	Light shale	10	..
7	23	30	8	134	Shell rock (?)	5	6	Drift	..	..	"Soapstone"	18	..			
11	23	30	8	146	"Soapstone"	17	..	Rock	2	..	"Soapstone"	6	..	Coal	1	..
											Rock	4	..			
21	23	30	8	124	Drift	..	..				Sandy shale	65	..			
17	26	30	8	133	Black slate and coal	2	..	Sandstone	3	..	Sandstone	51	..			
18	26	30	8	118	Soft sandstone (drift?)	..	..	Drift	..	..	Slate	1	..	Black slate	7	..
											Shale	1	..			
C. W. & V.	23	31	8	75	Black clod	..	..	Soft white clay	..	..	Fire clay	..	..	White calcareous sandstone	..	..
C. W. & V.	23	31	8	80	Black clod	..	..	Limy shale	..	..	Fire clay	..	..	White hard sandstone	..	..
9	25	31	8	47	Black slate	7	..	"Soapstone"	8	..	Fire clay	7	2	Shale	5	..
10	25	31	8	54	Black slate	7	..	"Soapstone"	7	..	Fire clay	2	..	Sandstone	20	..

TABLE 3 *Concluded*

No.	Location Sec.	TN	RE	Interval above coal No. 2 Feet	Roof	Ft.	In.	Strata above roof	Ft.	In.	Floor	Ft.	In.	Strata below floor	Ft.	In.
11	35	31	8	44	Black slate	5	..	"Soapstone"	12	..	Fire clay	10	..	Sandstone	10	..
15	36	31	8	63	Black slate	5	8	Sandstone	24	..	Fire clay	..	3	Limestone	6	..
7	35	32	8	86	Drift	..	..				Fire clay	2	2	Sandstone	..	8
45	7	32	8	81	Drift	..	..				Fire clay	8	..	Sandstone	39	..
43	8	32	8	75	Fire clay	2	6	Black slate	4	..	Fire clay	4	..	Sandstone	42	..
18	5	30	9	(No. 2 absent)	Black stone	7	7	"Soapstone"	6	6	Fire clay	10	8			
17	6	30	9	78	"Soapstone"	2	6	Drift	..	..	Fire clay	2	7	Limestone	12	..
16	7	30	9	80	Black slate	5	..	Fire clay	6	2	Fire clay	7	9	Limestone	2	..
20	8	30	9	36	Dark clod	6	3	Black slate	9	..	Fire clay, slate & clod	6	2	Coal	..	10
														Fire clay	..	1
22	16	30	9	84	Black slate	3	8	Drift	..	..	Fire clay	8	..	Calcareous sandstone	20	..
41	19	31	9	46	Black slate	6	6	"Soapstone"	13	..	Fire clay	13	..	Limy sandstone	3	9
42	19	31	9	(No. 2 absent)	"Soapstone"	4	6	Black slate	6	..	Fire clay	1	1			
45	30	31	9	(No. 2 absent)	Black slate	8	8	"Soapstone"	13	..	Fire clay	6	..	Black slate	5	..
46	30	31	9	56	Black slate	6	2	"Soapstone"	11	6	Fire clay	3	..	Calcareous sandstone	2	..
48	30	31	9	(No. 2 absent)	Hard, gray sandstone	15	3	"Soapstone"	30	..	Fire clay	..	9			
49	30	31	9	(No. 2 absent)	"Soapstone"	4	6	Black slate	8	2	Fire clay	1	..			
50	30	31	9	(No. 2 absent)	"Soapstone"	6	..	Black slate	7	..	Fire clay	1	..			
51	30	31	9	(No. 2 absent)	"Soapstone"	3	..	Black slate	6	..	Fire clay	1	..			
35	30	31	9	(No. 2 absent)	"Soapstone"	5	5½	"Soapstone"	7	10	Fire clay	4	5			
12	31	31	9	77	Dark clod	6	10	Black slate	3	6	"Soapstone"	6	..	Fire clay	10	..
														Sandstone	20	..
2	20	32	9	56	Drift	..	..	Sandstone	15	..						

TABLE 4.—*Stratigraphic data showing the interval between coal No. 2 and an intermediate coal (possibly No. 7), in the Cardiff field; showing also the thickness of the upper bed, and the character of the associated strata*

(Based upon diamond drill records)

Log No.	Location			Interval No. 2 to No. 7	Strata above No. 7				Strata below No. 7			Thickness of coal
	Sec.	*T.N.*	*R.E.*				*Ft.*	*In.*		*Ft.*	*In.*	*Inches*
1	27	30	8	73	1	Soft light shale	..	7	Dark shale	1	1	10
					2	Black shale	2	6	Fire clay	9	..	..
					3	Fire clay	12	6				
2	22	30	8	41	1	Dark stone	..	10	Fire clay	5	..	42
					2	Dark coal rock	1	2	Hard brown shale	3	..	..
3	22	30	8	86.8	1	Light shale	..	4	Light shale	5	4	4
					2	Black stone	2	..	Lime shale	3	..	..
4	23	30	8	46	1	Black stone	3	10	Light clay shale	3	..	38
					2	Dark shale	2	..	Light shale	3	..	..
5	23	30	8	84.6	1	Soft gray shale	2	2	Brown shale	..	6	40
					2	Black shale	2	..	Light shale	5	..	..
					3	Gray shale	5	..				
6	23	30	8	44	1	Light shale and coal	5	..	Light shale	1	..	24
					2	Gray shale	1	6	Fire clay and hard rock	7	6	..
					3	Limestone	3	..				
7	23	30	8	58	1	Black stone	2	9	Fire clay	2	4	17
					2	Dark shale	..	6	Limestone	3	..	..
					3	Dark shale with rock	32	..				
8	23	30	8	47	1	Black stone	1	2	Fire clay	13	4	24
					2	Hard dark rock	..	6				
					3	Black stone	2	..				

TABLE 4.—*Continued*

Log No.	Location			Interval No. 2 to No. 7	Strata above No. 7				Strata below No. 7			Thickness of coal
	Sec.	*T.N.*	*R.E.*				*Ft.*	*In.*		*Ft.*	*In.*	*Inches*
9	23	30	8	67	1	Black stone	..	6	Fire clay, limestone bands	10	..	24
					2	Hard gray rock	..	6	Dark shale	12	..	..
					3	Black stone	2	6				
10	22	30	8	36	1	Dark shale	..	6	Fire clay	..	8	42
					2	Fire clay	2	..	Light shale	5	..	..
					3	Dark shale	..	6				
11	23	30	8	46	1	Dark shale	2	..	Fire clay	4	6	42
					2	Light shale	5	..	Hard limestone	1	..	..
12	27	30	8	38	1	Black stone	2	6	Gray shale	1	..	..
					2	Dark shale	1	6	Fire clay	5	..	..
13	22	30	8	76	1	Dark shale	..	6	Hard sandy limestone	2	4	20
					2	Hydraulic rock	1	..	Fire clay	9	6	..
14	27	30	8	41	1	Black stone	1	8	Light shale	11	9	43
					2	Fire clay	..	..	Gray shale	1	..	..
17	26	30	8	37	1	Black shale	18	..	Light shale	1	..	36
					2	Black stone	3	..	Fire clay and sulphur	21	..	..
18	26	30	8	58	1	Sandy shale	5	..	Fire clay	2	..	36
					2	Hard sandy shale	5	..	Light shale	20	..	(clay & stone)
19	26	30	8	42	1	Sandy shale	15	..	Sandstone	8	..	36
					2	Black stone	4	..	Sandy shale	10	..	..
20	26	30	8	88	1	Dark shale	6	..	Light shale	..	7	41
					2	Light shale	6	2	Soft light shale	19	..	..

TABLE 4.—*Concluded*

Log No.	Location			Interval No. 2 to No. 7	Strata above No. 7				Strata below No. 7			Thickness of coal
	Sec.	*T.N.*	*R.E.*				*Ft.*	*In.*		*Ft.*	*In.*	*Inches*
21	23	30	8	60	1	Light shale	3	..	Gray shale	2	..	36
					2	Dark shale	2	..	Sandstone	2	..	..
22	22	30	8	83	1	Light shale	9	..	Light shale	3	..	6
					2	Dark shale	2	6	Clay shale	8	..	..
23	22	30	8	85	1	Black shale	2	..	Gray shale	6	..	24
					2	Light shale	3	4	Limestone	..	6	..
24	23	30	8	84	1	Light shale	3	..	Light shale	4	3	9
					2	Dark shale	2	..	Sandstone	17	..	..
25	23	30	8	84	1	Dark shale	3	..	Light shale	12	2	10
					2	Light shale	11	8	Sandstone	15	..	..
26	26	30	8	63	1	Light and dark shale	6	..	Light shale	12	6	42
					2	Limestone	2	..	Sandy shale	5	..	..
27	26	30	8	61	1	Black shale	4	6	Light shale	6	9	33
					2	Light clay shale	8	11	Light shale	4	..	..
28	26	30	8	51	1	Dark blue shale	8	9	Light blue shale	7	11	40
					2	Limestone	..	..				
30	22	30	8	81	1	Dark shale	1	..	Light shale	25	..	16
					2	Light shale	12	9				
31	23	30	8	85	1	Blue shale	3	..	Light shale	3	8	28
					2	Light shale	10	..	Light shale	5	..	..
32	28	30	8	71	1	Sandstone	4	..	Fire clay	5	..	30
					2	Fire clay	4	..	Sandstone	2	..	..

The roof of this coal bed is more regularly dark shale like the roof of coal No. 7 elsewhere in the district, and the interval between this coal and coal No. 2 approaches the average for the district. There are certain holes, however, those in which the "big vein" is found, where the interval is much less than average (see also cross-sections, Plate V). In thickness the coal is unusually variable and thins out, especially in those holes around the border of the Cardiff basin.

It is thought that this field presents a good opportunity to study the relative amount of shrinkage of coal and associated strata. There seem to be differences as great as 40 feet, and certainly as great as 20 feet, in the interval between coals No. 2 and No. 7 (?) in the holes in which the "Cardiff vein" was encountered, as compared with those in which it was not present. The greater interval of about 80 feet between coal No. 2 and coal No. 7 was found regularly where the "big vein" was missing, whereas in every hole in which the interval was 60 feet or less the thick coal was found. It seems not unlikely, therefore, that variations in interval as much as 20 feet may be due to causes not related to shrinkage of the Cardiff bed, whereas additional variations possibly as much as another 20 feet may be due to differences in the amount of shrinkage of the coal and shale. Variations in interval as great as 20 feet not due to differences in shrinkage of underlying strata are found at various places in the Wilmington-Cardiff field, as can be seen by referring to Table No. 3.

The thickness of this intermediate coal bed at Cardiff ranges up to 43 inches, the average in 28 holes being 28 inches of coal. Of these 28 holes, 13 show 36 inches or more of coal, and 4 show 42 or 43 inches. This coal bed seems to be more variable in thickness than coal No. 2 and to be limited in workable thickness to approximately the area of the "big vein." The coal is thinner than the upper bed which has been tentatively correlated with coal No. 7 in this report, but is more widespread, as it has not been anywhere removed by preglacial erosion.

Pottsville Coals

Coal No. 1, or the Pottsville coal, is of no economic importance in the Longwall District, so far as is known. Thin seams of coal below coal No. 2 are encountered in drilling in the field in the vicinity of Bureau, west of Marquette and Granville. The coal beds are apparently two or three in number, each having a local distribution and a thickness not exceeding 2 feet (see Plate IV, Nos. 11 and 12). East of the anticline and along the fold itself stringers of coaly matter have been noted in a few places in the clay underlying coal No. 2. Such a thin coal bed occurs in the clay at the exposure near the Bottomly

local mine along Vermilion River about three-fourths of a mile below Lowell. In the Coal City and South Wilmington field and in the Cardiff field thin stringers of coal have been observed in the underclay of coal No. 2.

Local and Thin Coal Beds Between Coal No. 2 and Coal No. 7 (Not Including Coal No. 5).

CARDIFF COAL

The coal bed between coals No. 2 and No. 7 except for coal No. 5, that is of economic importance is the "big vein" in the Cardiff field, which we will call the Cardiff coal. The exact correlation of this coal with others in this district or in the State has not been determined. It has already been suggested that this coal may be about the same age as the fossil-insect and leaf bed along Mazon Creek in Grundy County, which was deposited soon after the accumulation of the peat of coal No. 2.

In order that the relationship of the Cardiff coal to the other strata in the section may be made as clear as possible, a map showing the location of the various holes and cross-sections of the field is presented in Plate V. The contours are drawn on the base of coal No. 2 and to that extent represent an enlargement of a portion of the map of the Longwall District (Plate I). The positions of the three cross-sections is indicated by the heavy straight lines on the map. The details of the sections are not shown, but the thicknesses and intervals between coals are drawn to scale so that the relations are apparent. The thickest core of the Cardiff coal was 150 inches, though this was not all good, clean coal. The coal thins to 5 or 6 feet and becomes dirty toward the eastern end of the field and to the west is split up by bone and shale. The coal stops abruptly north and south.

The shape of the coal bed is strikingly lenticular and crescentic in cross-section. The edges of the bed dip strongly toward the trough, possibly even more so than is indicated by the drawing. The feathering of the bed at the edges as shown in cross-section Plate V, *D* represents the conditions as shown in the drilling records; it is reported however that the bed tapers out on either side rather than feathers out, the bottom of the bed rising toward the top. There was possibly about 600 to 1000 feet of relatively flat-lying coal north and south along the axis of the trough. The coal is reported to contain more impurities toward the southeast and to be divided by a layer of clay. The shale which forms the floor of the Cardiff coal and the roof of coal No. 2 is commonly a thin sandstone and pebble conglomerate overlain by a thin black shale or hard underclay which locally merges with the bottom part of the upper bed and makes it bony and unmarketable.

The sections presented in Plate V show graphically the relation of the Cardiff coal to coal No. 2 and to the overlying strata. Plate V, *C* and *D* both show how the upper coals decrease in altitude where the Cardiff coal lies below. It is thought probable, as has already been suggested, that the relatively greater shrinkage of the strata containing the Cardiff coal as compared with the amount of shrinkage of a corresponding original thickness of shale would account for this decrease in interval between coal No. 2 and the coals above the Cardiff bed. There seems to be some response on the part of coal No. 2 where the Cardiff coal is present above. The sections suggest that this coal rises toward the Cardiff bed, but not all the profiles bear this out.

The coal bed that lies from 40 to 85 feet above No. 2 coal at Cardiff has already been described as possibly being coal No. 7. This coal has about the same distribution as the Cardiff bed, but is of little or no economic importance.

In the vicinity of Lowell a thin bed of cannel coal less than a foot in thickness is exposed along the Vermilion and its tributaries. The coal lies below the heavy sandstone underlying No. 5 coal. It is associated with 2 or 3 feet of black, carbonaceous shale into which it grades, and which locally becomes more like coal. This bed is of no economic importance, at least at present.

COAL NO. 6 AT STREATOR

In the Kangley-Henanville field and possibly along the south edge of the city of Streator, a coal is locally developed a few feet below or immediately below coal No. 7. The mine at Henanville is reported to have worked both beds where they were together and measured about 9 feet thick. At present the lower bed is worked in local banks east of Kangley at Spring Hill. It is thought that this coal bed is confined to about the same basin as is the Henanville-Kangley No. 7 coal, and lies at a lower horizon in this basin, and that it is not found generally outside of the basin. On the other hand, certain records of drilling south of Streator in Livingston County show at the horizon of coal No. 7, a thick split bed of coal which suggests the presence of two beds of coal in close proximity. The characteristics of these local beds are not well known, but so far as can be determined none possesses the "blue band," or has the *Fusulina*-bearing, limestone cap rock.

COAL NO. 6 AT SPARLAND

Coal No. 6 at Sparland lies about 25 feet below the "upper vein" or coal No. 7. In the immediate vicinity of the town it varies from a very thin bed to about 2 feet. Farther south certain drill records in T. 29 N., R. 9 E., show the lower coal from 30 to 50 feet below coal

No. 7 and varying in thickness up to 56 inches. This coal becomes workable in the vicinity of Chillicothe where it has been identified as No. 6. The coal in the vicinity of Sparland has been seen only where it is very thin, but it seems not to possess a blue band. Locally, within 4 or 5 feet above the coal, in the Sparland field is a yellowish, fossiliferous, earthy limestone resembling very much the limestone commonly forming the cap rock above coal No. 6 in Peoria and Fulton counties and even in the southern part of the State. No *Fusulina* have been found in the stratum in this field, however. The fauna which it contains is suggestive of the Carbondale rather than of the McLeansboro formation, so that the coal is probably at least as old as coal No. 6.

Local and Thin Beds of Coal Above Coal No. 7

The only coal of possible workable thickness above coal No. 7 is a bed found locally along Vermilion River in sec. 18, T. 30 N., R. 4 E., Livingston County. The coal outcrops along the sides of a valley tributary to the Vermilion, near the mouth of the creek. Where observed the bed is 30 inches thick, is underlain by a shale resembling fire clay, and overlain by gray shale. To the west and south along Vermilion River the coal does not seem to be present, the horizon being occupied by siliceous strata. So far as known the coal is of but local extent, but there is lack of drilling to confirm this assumption.

In the vicinity of Spring Valley and south of the town on the opposite bluff of the Illinois, a thin bed of coal a foot or so in thickness outcrops near the foot of the bluff in some of the ravines. It appears in a cut along Spring Creek almost at the water's edge across from mine No. 1 of the Spring Valley Coal Co. Here it is only a few inches thick. Along the south bluff of the Illinois at the mouth of some of the ravines in secs. 28 and 29, T. 33 N., R. 1 W., Putnam County, the coal is a foot or so in thickness and has been used somewhat by farmers. This coal is about 50 feet below the horizon of the La Salle limestone.

So far as known, only the coals described in the preceding pages have been mined or stripped and used for fuel within the Longwall District. Some of these are of little or no economic importance, but their position in the section is worthy of note, because a few are associated with other strata that may be of some value. Other small coal beds are scattered throughout the Pennsylvanian system in this district, such as the stringer of coal associated with the black slate under the La Salle limestone. This coal is of rather widespread occurrence and of some value in tracing the horizon of the limestone, but is of no importance as fuel. The upper calcareous portion of the McLeansboro formation above the Lonsdale limestone horizon contains possibly a greater number of these thin coal stringers than the underlying por-

tions of the Pennsylvanian, at least down to within 50 feet of coal No. 2.

CHEMICAL COMPOSITION AND HEAT VALUES OF COALS

A detailed report on the chemical character and heat values of coals in this district and in other districts of the State is being prepared by Prof. S. W. Parr as Bulletin 3 of the Illinois Coal Mining Investigations. Only general features are presented here. Plate IX shows graphically the relative composition of the coals of Illinois.

Coal No. 2

The composition of the coal in the Longwall District has been determined from samples collected in 1913 by members of the Coal Mining Investigations from three different working faces in each of eleven mines. The average analysis of the samples from each of the mines is shown below, and also the average of the 33 samples.

Table 5.—*Average analysis of samples of coal No. 5 collected from mines in the Longwall District—Made under the direction of Professor S. W. Parr*

Co-op. No.	Moist-ure	Volatile matter	Fixed carbon	Ash	Sul-phur	CO_2	B. t. u.	Unit coal
1	16.19	37.79	38.06	8.00	3.24	.82	10787	14476
	Dry	45.06	45.40	9.54	3.86	.98	12869	
2	14.60	39.88	36.97	8.55	3.97	.81	10904	14475
	Dry	46.70	43.29	10.01	4.65	.95	12768	
3	15.05	39.76	37.00	8.19	3.30	.59	10899	14454
	Dry	46.80	43.56	9.64	3.88	.69	12830	
4	16.93	37.57	39.57	5.93	2.53	.37	11188	14696
	Dry	45.22	47.64	7.14	3.05	.44	13468	
5	16.01	39.32	38.51	6.16	2.75	1.32	11104	14463
	Dry	46.83	45.84	7.33	3.28	1.57	13221	
6	19.53	37.59	37.94	4.94	2.01	.70	10818	14447
	Dry	46.71	47.15	6.14	2.61	.87	13444	
7	16.29	38.46	40.53	4.72	2.17	.48	11394	14579
	Dry	45.94	48.42	5.64	2.59	.57	13613	
8	16.50	38.48	37.59	7.43	2.40	1.16	10868	14493
	Dry	46.02	45.02	8.90	2.90	1.39	13108	
9	17.45	38.98	34.52	9.04	3.18	1.49	10391	14403
	Dry	47.22	41.82	10.95	3.85	1.81	12587	
10	16.13	38.82	38.36	6.69	3.15	.70	10994	14463
	Dry	46.28	45.74	7.98	3.76	.84	13108	
11	13.28	40.58	37.71	8.43	3.04	.60	11435	14856
	Dry	46.80	43.48	9.72	3.51	.69	13186	
Aver.	16.18	38.84	37.89	7.98	2.88	.82	10980	14528
	Dry	46.33	45.21	8.45	3.45	.98	13101	

In order to show a comparison of the heating quality of this coa with that of other coals in the State, Table 6 showing the averag and extreme values for the coals of 9 different districts is insertec (See also Plate IX.)

TABLE 6.—*The comparative heating value of the various Illinois coals*
(Data after Parr)

District		B. t. u.		
		Minimum	Maximum	Average
La Salle, No. 2	As rec'd	10391	11435	10981
	Dry	12587	13468	13101
Franklin, Williamson, and Perry, No. 6	As rec'd	11335	12127	11825
	Dry	12583	13366	13025
Harrisburg, No. 5	As rec'd	12053	12550	12276
	Dry	12784	13490	13165
Springfield-Peoria, No. 5	As rec'd	10230	10951	10514
	Dry	11995	12700	12384
Danville, No. 6	As rec'd	10508	11228	10920
	Dry	12449	12925	12764
Danville, No. 7	As rec'd	.....	.....	11151
	Dry	.....	.....	12807
Belleville, No. 6	As rec'd	10438	11207	10847
	Dry	12150	12801	12406
Murphysboro, No. 2	As rec'd	12260	12651	12488
	Dry	13565	14044	13765
Rock Island, No. 1	As rec'd	10336	10880	11036
	Dry	12548	12737	12753
Average	As rec'd	10944	11624	11388
	Dry	12776	13181	12797

The preceding table shows that in heating quality the No. 2 coal c the Longwall District, as received from the mine, ranks sixth amon the coals of the State, being surpassed by No. 2 coal of Jackson Count No. 5 coal of the Harrisburg District, No. 6 coal of Williamso Franklin, and Perry counties, No. 7 coal of the Danville District, an No. 1 coal of the Rock Island District. It has higher heating valu than No. 5 coal of the Springfield-Peoria District and No. 6 coal c Belleville and Danville District.

The amount and character of the impurities in No. 2 coal is show in the preceding tables. These have an important effect on the heatin qualities of the coal and the ease with which it is burned. The pro

portion of water in this coal is greater than in any other coal in the State, and its effect is, of course, to reduce the heating value in proportion. Parr[2] has stated that the heat of vaporization at 212 degrees F. is 972 B. t. u. per pound of water. The average amount of moisture present in the Longwall coal is 16.18 per cent, that is, a pound of coal is 16.18 per cent moisture; so the heat required to vaporize the water would be 156 B. t. u., and the available B. t. u. would be reduced by that amount.

The average ash content of Illinois coals on a moisture-free basis is 10.07 per cent, and the sulphur 3.21 per cent. The Longwall coal has an average ash content (8.45 per cent) that is less than the average for the State, and a sulphur content (3.45 per cent) that is only slightly above the average. The amount of sulphur is usually regarded as an index of the clinkering properties because of its association with iron which tends to fuse with the siliceous matter of the ash to form clinkers.

Coal No. 5

The chemical character of coal No. 5 in the Longwall District has been determined by analysis of three samples during 1912, which are averaged in the following table:

Table 7.—*Analysis of coal No. 5 in the La Salle region*
(Average of three samples from one mine)

	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B. t. u.	Unit coal
"As received"	14.76	34.26	41.33	9.65	3.38	10,672	14,397
"Dry coal"	.....	40.19	48.49	11.32	3.97	12,543	.....

The B. t. u. "as received" (10,672) is below the district average for coal No. 2 (10,980). The coal in this condition is slightly superior to the Springfield-Peoria coals. The "dry-coal" value of 12,543 is surpassed by that of all the other coals of the State except No. 5 of the Springfield region and No. 6 of the Belleville region. The moisture content of the coal where sampled is higher than that of the southern Illinois coals of Saline, Williamson, and Franklin counties, but evidently does not exceed that of coal No. 2 of the Longwall District. Ash and sulphur are both rather high in this coal if the samples collected are representative. The coal contains about the same proportion of ash and sulphur as No. 5 coal in Fulton County, but a greater amount than coal No. 2 except possibly the coal in Grundy County. In general, coal No. 5 seems to be slightly inferior to coal No. 2 of this district and to the southern Illinois coals No. 5 and No. 6, but to be slightly superior to the Springfield coal. Only a few analyses of coal No. 5 in the [illegible]

[2]Parr, S. W., the chemical composition of Illinois coal: Ill. State Geol. Survey Bull. No. 3, 1906, p. 227.

trict are available, however, and therefore reliable conclusions for the entire area cannot be drawn.

Coal No. 7

Like coal No. 5, coal No. 7 in this district has been only slightly tested. The average of three analyses collected in 1912 are tabulated below.

Table 8.—*Analysis of coal No. 7 in the Longwall District (Average of three samples from one mine)*

Condition	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B. t. u.	Unit coal
"As received"	13.56	37.80	40.81	7.77	3.68	10,348	14,685
"Dry coal"	.....	43.73	47.28	8.99	4.26	13,127	.....

Coal No. 7 according to this analysis resembles coal No. 5. The coal is possibly not quite so good as No. 5 at La Salle. It has less moisture but more ash and sulphur than coal No. 2, and more moisture than the southern Illinois coals.

CHAPTER IV—WORKING DATA

INTRODUCTION

In the pages that follow, statistics of the coal production for the Longwall District since 1870 are presented by counties. A rough estimate is attempted also of the amount of coal still available in the district. Livingston and Woodford counties, lying for the most part outside of the Longwall District, are not considered in the summaries, and only the eastern part of Marshall County is considered. The figures for Bureau County are more or less unsatisfactory, because the early production of that county was from the higher coals in its western part beyond the Longwall District.

The available statistics before 1886 are those of the census of 1870 and 1880, production for the intervening years being estimated about the same. This gives rise to some error, but, inasmuch as the productions of those earlier years were relatively small as compared with the production of later years or with the total productions, the error is not large. For the dates since 1886 the figures given in the volumes of Mineral Resources published by the U. S. Geological Survey are used. These statistics are based on the calendar year, January 1 to December 31. In comparing the figures given in the following pages with the statistics presented by the State Mining Board, it should be borne in mind that the latter figures are based on the fiscal year running from July 1 to June 30.

In estimating the amount of the coal under a given area a weight of 1770 tons per acre-foot is assumed, Illinois coal having an average specific gravity of about 1.3.

The list of mines operating in each county includes only the active shipping mines during the present year (1914) in so far as we have been able to eliminate the others. Only those mines that lie within the Longwall District are included in the lists. The map of the area (Plate III) shows the locations and the names of all these mines and also of several local and abandoned mines that are either mentioned in the text or are of geographical importance. Appended to the list of the mines is information showing the location of the mine in the section, the name of the mine, the elevation of the surface, depth to the coal, the elevation of the top of the coal bed, and the thickness of the coal. Where available additional information regarding the depth, elevation, and thickness of the other coals in the section is given.

As little space as possible is given in the earlier parts of this report to data from drill records and sections. Such material forms a very important source of our information in regard to the geology of the Illinois coal fields because of the widespread glacial drift and the scarcity of outcrops. Therefore, it seems advisable to present a few records and sections showing the characteristic conditions in the different counties covered by this report. Reference has been made to most of these records in the first parts of the bulletin, and each is selected as being representative of that part of the county in which it is located. In some areas there was little opportunity for selection, as only one or two holes of sufficient depth to give a valuable record, had been drilled. This is especially true in Livingston County and in eastern La Salle and western Grundy counties. The best records available from those localities, except for the region around Cardiff, are not highly accurate. All the records have been interpreted geologically, so that the depths and thicknesses of the different formations can be readily determined. Most of the records have not been presented hitherto, the special exception being the old La Salle County generalized section by Freeman. This has been changed in some particulars. The record of the drilling at Streator appeared in the 17th Annual Report of the U. S. Geological Survey Part II, p. 798, and the record for the drilling at Depue in Bulletin 24, State Geological Survey, p. 48.

The reliability of the records varies. Those from deep wells primarily for artesian water are all obtained by churn drills, and the determinations of depth for the different strata are more or less inaccurate, especially those from wells drilled 25 or 30 years ago. Their general agreement with more recent determinations, however, increases their value. The records of coal test-holes are all from diamond drills, and most of them are more reliable than the churn-drill records, at least for the depth and thickness of the coal. Except with reference to coal the reliability of the diamond-drill record depends largely on the willingness of the driller to make careful observation. Too often the additional expense of drilling with a diamond drill is wasted because the core is not safeguarded and carefully interpreted. Those who contemplate prospecting with a diamond drill are urged to give proper attention to the intermediate strata between the coal beds, and if possible to store the core until it can be seen by a competent geologist. Especially should these cautions be observed in a new field, or where the structure is uncertain. The diamond-drill records presented in the following pages are possibly open to much criticism, but they represent out best data.

Several of the logs are of a confidential nature and for that reason either the location of the hole is given only in a general way or the confidential information is obscured in some other manner.

BUREAU COUNTY

Statistics

COAL NO. 2

Area of the county in the Longwall District originally underlain by coal No. 2, in square miles	300
Area underlain by workable coal, in square miles	120
Amount of coal available in tons, average thickness, 36 inches	407,808,000

COAL NO. 5

Area of the county in the Longwall District originally underlain by coal No. 5, in square miles	102
Area underlain by workable coal, in square miles	50
Amount of coal available in tons, average thickness, 36 inches	169,920,000

COAL NO. 7

Area of the county in the Longwall District originally underlain by coal No. 7, in square miles	73
Area underlain by workable coal, in square miles	40
Amount of coal available in tons, average thickness, 36 inches	135,936,000

TOTALS FOR COUNTY

Total tonnage originally available	713,664,000
Total tonnage produced by Bureau County between 1870 and the end of 1913, approximately	34,368,057
Percentage already used of total supply	3.4
Number of shipping mines in the Longwall District of Bureau County in 1913	7

Table 9 shows the output of coal for Bureau County in 1870 and 1880 and annually from 1886 to 1913, inclusive. The third column is the relative production of Bureau County as compared with the total State tonnage.

TABLE 9.—*Production of coal in Bureau County since 1870, and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	32,339	1.2	1899	1,400,908	5.7
1880	65,890	1.07	1900	1,318,784	5.1
1886	140,562	1.2	1901	1,594,803	5.8
1887	429,580	3.5	1902	1,769,643	5.3
1888	635,097	4.4	1903	1,846,642	4.9
1889	493,730	4.1	1904	1,821,867	4.9
1890	372,701	2.4	1905	1,701,255	4.4
1891	701,064	4.5	1906	1,580,085	3.8
1892	943,496	5.3	1907	2,010,762	3.9
1893	1,143,270	5.7	1908	1,512,971	3.1
1894	878,937	5.1	1909	1,612,452	3.1
1895	834,541	4.7	1910	973,346	2.1
1896	1,042,304	5.5	1911	1,628,088	3.0
1897	1,145,312	5.5	1912	1,677,317	2.8
1898	865,892	4.6	1913	1,639,208	2.6

TABLE 10.—*Names and locations of the shipping mines operating in the Longwall District of Bureau County, and the depths, thicknesses, and elevations of the coal beds*

Name of company	Name of mine	Location ¼	¼	Sec.	T. N.	R. E.	Elevation shaft	Depth to coal	Elev. of coal	Thickness of coal	No. of bed
							Feet	*Feet*	*Feet*	*Inches*	
Illinois Third Vein Coal Co.	Ladd	NW	SW	10	16	11	653	465	188	42	2
Marquette Third Vein Coal Co.	Marquette	NW	SE	31	16	11	466	282	184	42	2
Spring Valley Coal Co.	No. 1	SW	SW	35	16	11	470	336	134	42	2
				..	..	..	..	161	309	66	5
				..	..	..	..	111	359	48	7
Spring Valley Coal Co.	No. 3	SE	NW	33	16	11	598	453	145	42	2
Spring Valley Coal Co.	No. 4 (Seatonville)	SE	SW	18	16	11	585	389	196	42	2
Spring Valley Coal Co.	No. 5 (Dalzell)	SW	SW	24	16	11	568	418	150	42	2
				..	..	..	..	246	322	42	5
St. Paul Coal Co.	Cherry	SW	NW	27	17	11	694	486	208	42	2
				..	..	..	..	316	378	62	5
				..	..	..	..	271	423	44	7

Drill Records and Geological Sections From Bureau County

In the following pages are given four logs showing the succession of strata in Bureau County. The first record is the log of a boring through the drift where it nearly reaches its known maximum thickness in the county; the second record shows the Pennsylvania series where it has an unusual thickness for this county; the third shows the strata underlying the "Coal Measures" down to the Galena-Trenton limestone; and the fourth records shows the strata in the area west of Bureau, where the Pottsville is unusually thick.

Partial log of a drilling for coal in the NW.¼ SW.¼ sec. 10, T. 17 N., R. 10 E., Bureau County, showing the character of the drift

(Geologic interpretations by the author)

Plate IV, No. 13

Description of Strata	Thickness *Feet*	Depth *Feet*
Recent and Pleistocene series—		
Upper drift—		
Clay, yellow	18	18
Clay, gray	55	73
Gravel	2	75
Clay, brown	53	128
Gravel in clay	2	130
Sand, muddy	11	141
Clay, brown, and rotten wood	9	150
Middle drift—		
Clay, brown	3	153
Clay, gray	2	155
Clay, green	4	159
Sand, fine	5	164
Sand	4	168
Clay, pebbly	4	172
Sand	2	174
Clay, pebbly	2	176
Gravel, coarse	4	180
Sand	2	182
Gravel	6	188
Clay, pebbly	4	192
Sand	2	194
Gravel	4	198
Clay, brown sandy	3	201
Clay, green	6	207
Clay, brown, sandy	8	215
Clay, green	9	224
Clay, sandy	9	233
Sand and gravel	12	245
Sand	2	247
Gravel, coarse	1	248
Clay, sandy	10	258
Clay, sandy, with rotton wood	8	266

	Thickness	Depth
Lower drift (?)—	*Feet*	*Feet*
Sand with rotten wood	14	280
Sand, coarse	16	296
Sand, fine	8	304
Sand	4	308
Gravel	3	311
Sand, red	24	335
Gravel	8½	343½

Record[1] *of the shaft of Mine No. 5, Spring Valley Coal Co., Dalzell, Illinois, showing the "Coal Measures" in Bureau County down to coal No. 2*

(Geologic interpretations by the author)

Plate IV, No. 8

Description of Strata	Thickness		Depth	
Pleistocene and recent series—	*Ft.*	*In.*	*Ft.*	*In.*
Surface	8	6	8	6
Pennsylvanian series—				
McLeansboro and Carbondale formations—				
Limestone	6	..	14	6
Fire clay	5	..	19	6
Shale, red ("paint rock")	5	..	24	6
Shale ("soapstone")	3	6	28	..
Limestone	1	6	29	6
Stone, black	1	..	30	6
Rock, gray	2	2	32	8
"Soapstone"	4	6	37	2
Coal	..	4	37	6
"Soapstone"	2	..	39	6
Slate, blue	9	..	48	6
Limestone	14	..	62	6
Fire clay	8	..	70	6
"Soapstone"	4	..	74	6
Limestone	8	..	82	6
Rock, black	4	..	86	6
Fire clay	6	..	92	6
"Soapstone"	4	..	96	6
"Slate", black	8	..	104	6
Shale, gray	1	9	106	3
"Slate" and "soapstone"	1	2	107	5
"Soapstone", gray	8	..	115	5
Limestone	6	..	121	5
"Slate", gray	8	..	129	5
Shale, blue	8	..	137	5
"Soapstone"	7	..	144	5
Stone, green	8	..	152	5
"Soapstone"	11	3	163	8

[1]Record from F. D. Chadwick, Engineer, Spring Valley Coal Co.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Pleistocene and recent series—				
Sandstone	11	..	174	8
"Slate," black	12	6	187	2
Shale, black	8	9	195	11
Coal No. 7	3	2	199	1
"Soapstone"	12	2	211	3
"Soapstone"	8	..	219	3
Sandstone	6	..	225	3
Shale	10	9	236	..
"Slate", black	7	7	243	7
Coal No. 5	3	6	247	1
Shale, gray	1	..	248	1
Shale ("soapstone")	3	..	251	1
Sandstone	7	..	258	1
Shale	8	..	266	1
Sandstone	19	..	285	1
Shale, ("soapstone")	21	..	306	1
Sandstone and shale	13	..	319	1
Sandstone	11	4	330	5
Shale	13	..	343	5
"Slate", black	3	..	346	5
Shale	5	..	351	5
Sandstone	6	..	357	5
"Slate", black	3	..	360	5
Fire clay	7	..	367	5
Sandstone	8	..	375	5
Shale	23	..	398	5
"Slate", black	3	..	401	5
Shale ("soapstone")	15	..	416	5
Coal No. 2	3	5	419	10

Log[2] of artesian well No. 2 owned by the Mineral Point Zinc Co., Depue Illinois, showing the character of the strata from surface to within the Galena-Trenton limestone

(Geologic interpretations by the author)

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Recent and Pleistocene series—				
Clay, soft yellow	..	..	13	..
Gravel, coarse	22	..	35	.
Gravel, coarser	2	..	37	
Gravel and sand, fine	16	.	53	..
Sand, clear	11	.	64	..
Gravel and sand	14	..	78	..
Pennsylvanian series—	..			
Shale, light and soft	12	..	90	
Shale, dark, soft	10	.	100	

[2]Log presented by the Mineral Point Zinc Co. See also Udden, J. A., Some deep borings in Illinois: Ill. State Geol. Survey, Bull. 24, p. 1914.

Description of Strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Shale, light, medium hardness	32	..	132	..
Shale, dark, medium hardness	50	..	182	..
Coal, very lean	2	6	184	6
Shale, dark, medium hardness	20	6	205	..
Shale, dark, harder..........	11	..	216	..
Shale, light, medium hardness	11	..	227	..
Shale, dark, medium hardness	45	..	272	..
Shale, dark, harder	3	..	275	..
Shale, light, medium hardness	17	..	292	..
Shale, darker, medium hardness	8	..	300	..
Shale, light, medium hardness	45	..	345	..
Shale, dark, medium hardness	11	..	356	..
Coal, indications of..........	4	..	360	..
Shale, light	11	..	371	..
Silurian series—				
Niagaran formation—				
Limestone, white soft	31	..	402	..
Limestone, white soft........	133	..	535	..
Limestone, brown, medium hardness	45	..	580	..
Limestone, white, medium hardness	52	..	632	..
Limestone, darker, soft.......	71	..	703	..
Limestone, white, medium and hard	147	..	850	..
Ordovician series—				
Maquoketa formation—				
Shale, light, hard............	78	..	928	..
Shale and limestone.........	22	..	950	..
Shale, light, hard............	70	..	1020	..
Galena and Plattville formations—				
Limestone, white, hard......	45	..	1065	..
Limestone, white, medium hardness	213	..	1278	..

Log of drilling in the vicinity of Bureau, T. 15 N., R. 10 E.
Elevation of the surface 488 feet above sea level

(Geologic interpretations by the author)

Plate IV, No. 11

Description of Strata	Depth		Thickness	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene and recent series—				
Sand and gravel—				
Clay and quicksand	135	...	135	..
Pennsylvanian series—				
McLeansboro and Carbondale formation—				
Shale, gray	8	..	143	..
Shale, gray and black	4	..	147	..
Shale, black	3	..	150	..
Shale, gray	8	..	158	..
Limestone	2	..	160	..
Shale, blue	4	..	164	..
Limestone	1	..	165	..
Shale, blue	8	..	173	..
Shale, sandy, blue	6	..	179	..
Shale, blue and gray	28	..	207	..
Shale, black	3	..	210	..
Shale, gray	4	..	214	..
Coal No. 2	3	6	217	6
Pottsville formation—				
Fire clay	..	6	218	..
Shale, gray	15	..	233	..
Shale, sandy	2	..	235	..
Shale, gray	10	..	245	..
Shale, black	1	..	246	..
Shale, blue	2	..	249	..
Coal (No. 1 ?)	1	4	250	4
Shale, black and blue	13	8	264	..
Coal (No. 1 ?)	1	..	265	..
Shale	5	6	270	..
Shale, black, and coal	1	6	272	..
Shale, sandy	22	6	294	..
Shale, black	..	6	294	..
Shale, sandy	13	..	308	..
Silurian System (Devonian ?)—				
Niagaran formation—				
Limestone	5	..	315	..
Limestone, porous and wet	56	..	369	.

GRUNDY COUNTY

Statistics

COAL NO. 2

Area of the county originally underlain by coal No. 2, in square miles..	370
Area of available coal, in square miles..............................	300
Amount available in tons, average thickness 30 inches...........	849,600,000

COAL NO. 5

Area of the county underlain by coal No. 5 in square miles, negligible	0

COAL NO. 7

Area of the county underlain by coal No. 7 in square miles..........	15
Amount available, negligible......................................	0

TOTALS FOR COUNTY

Total tonnage originally available.................................849,600,000

Total amount mined to date probably between 30,000,000 and 35,000,000 tons representing 40,000,000 tons in the ground.

Percentage already used of total supply...........................	4.7
Number of shipping mines operating in Grundy County in 1913......	5

The shipping mines for Grundy County are listed in Table II, page 122.

Table 12 shows the output of coal of Grundy County in 1870 and 1880 and annually from 1886 to 1913 inclusive. The third column is the relative production of Bureau County as compared with the total State tonnage.

TABLE 12.—*Production of coal in Grundy County since 1870, and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	51,375	1.9	1899	1,257,092	5.1
1880	103,812	1.6	1900	1,315,688	5.1
1886	776,625	6.9	1901	1,269,741	4.6
1887	792,954	6.3	1902	1,414,479	4.2
1888	862,860	6.0	1903	1,392,427	3.7
1889	698,033	5.7	1904	1,334,422	3.6
1890	654,017	4.3	1905	1,310,892	3.4
1891	921,907	5.8	1906	1,162,019	2.8
1892	1,108,419	6.2	1907	1,327,321	2.5
1893	1,186,919	5.9	1908	1,091,442	2.2
1894	1,130,420	6.6	1909	1,114,101	2.1
1895	1,261,838	7.1	1910	600,281	1.3
1896	1,247,394	6.3	1911	776,800	1.4
1897	1,077,576	5.3	1912	540,787	.9
1898	796,249	4.2	1913	401,527	.6

DRILL RECORDS AND GEOLOGICAL SECTIONS FROM GRUNDY COUNTY

Two records of drilling in Grundy County are given. Both of these are of artesian wells and show the strata below the Pennsylvanian in some detail. The first record is from the southern part of the county where the Maquoketa shale underlies the "Coal Measures" and the other is from the northeast part of the county where the Galena-Trenton limestone lies under the Pennsylvanian strata.

Log[1] of well sunk on the farm of Ed Walker 2 miles south, 1 mile west of Mazon, Grundy County, Illinois, in the SW.¼ sec. 28, T. 31 N., R. 7 E.

(Geologic interpretations by the author)

Description of Strata		
Recent and Pleistocene series—	*Feet*	*Feet*
Soil	6	6
Clay, blue	160	166
Pennsylvanian series—		
Shale ("soapstone"), slate, black, 4 feet	40	206
Sandstone, blue	18	224
Shale ("soapstone")	34	258
Ordovician series—		
Maquoketa formation—		
Shale ("soapstone")	46	304
Slate, black	12	316
Shale (hardpan)	16	332
Galena-Trenton formation—		
Limestone, hard	216	548
Limestone, soft	60	608
Limestone, hard	12	620
St Peter formation—		
Sandstone, white	87	707

[1]Well drilled and record furnished by C. W. Johnson, Seneca, Ill

Record of an artesian well on the farm of Abe Hoge in the NW. ¼ NW. ¼ sec. 25, T. 34 N., R. 6 E., Grundy County. Well drilled in 1875

(Geologic interpretations by the author)

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene and recent series—				
Soil	5	..	5	..
Pennsylvanian series—				
Shale and sandstone	70	..	75	..
Ordovician system—				
Galena-Trenton—				
Limestone	200	..	275	..
Shale	2	..	277	..
St. Peter sandstone—				
Sandstone	200	..	477	..
"Cement" and shale	8	..	485	..
Sandstone (St. Peter ?)	60	..	545	..
Lower Magnesian formation—				
Limestone, white	185	..	730	..
Sandstone, white	93	..	823	..
Limestone, white	326	..	1149	..
Cambrian (?) system—				
Sandstone, red	166	..	1315	..
Limestone, gray	30	..	1345	..
Sandstone	317	..	1662	..
Limestone, gray	43	..	1705	..
Sandstone	163	6	1868	6

KANKAKEE COUNTY

Statistics

COAL NO. 2

Area of the county originally underlain by coal No. 2, in square miles	33
Area underlain by available coal, in square miles....................	30
Amount originally available in tons, average thickness 30 inches....	84,960,000

COAL NO. 5

Area of the county underlain by coal No. 5........................	0

COAL NO. 7

Area of the county underlain by coal No. 7, in square miles..........	9
Area of the county underlain by available coal in square miles (negligible)	0

TOTALS FOR COUNTY

Total tonnage originally available.................................	84,960,000
Total tonnage mined approximately 2,000,000 representing 3,000,000 in the ground.	
Percentage already mined...	3.5

Table 13 shows the output of coal of Kankakee County in 1870 and 1880 and annually from 1886 to 1913 inclusive. The third column shows the relative production of the county as compared with the total tonnage of the State.

TABLE 13.—*Production of coal in Kankakee County since 1870, and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	.....	..	1899	129,262	.5
1880	.....	..	1900	109,129	.4
1886	73,678	.6	1901	67,195	.2
1887	97,000	.7	1902	48,439	.1
1888	82,000	.5	1903	74,226	.2
1889	67,380	.5	1904	.....	..
1890	62,460	.4	1905	700	.01
1891	90,908	.5	1906	39,499	.09
1892	92,158	.5	1907	26,704	.05
1893	88,700	.4	1908	30,994	.06
1894	57,883	.3	1909	25,000	.04
1895	83,513	.4	1910	......	..
1896	72,395	.3	1911	......	..
1897	180,683	.9	1912	......	..
1898	84,632	.4	1913	......	..

During 1913 there were no commercial mines operating in Kankakee County. There has been no production reported from this county since 1910.

TABLE 11.—*Names and locations of the shipping mines operating in Grundy County in 1913, and the depths, thicknesses, and elevations of the coal beds*

Name of company	Name of mine	¼	Location ¼	Sec.	T. N.	R. E.	Elevation shaft	Depth to coal	Elev. of coal	Thickness of coal	No. of bed
							Feet	*Feet*	*Feet*	*Inches*	
Big Four Wilmington Coal Co.	No. 5	SE	NE	33	33	8	565 ap	114	451	36	2
Wilmington Star Coal Co.	No. 5	NW	SE	3	32	8	562 ap	69	493	36	2
Wilmington Star Coal Co.	No. 6	SE	NE	4	32	8	562 ap	126	436	40	2
Chicago, Wilmington & Vermilion Coal Co.	No. 3	Centre	..	23	31	8	590 ap	185	405	39	2
Chicago, Wilmington & Vermilion Coal Co.	No. 1	Centre NW	NE	14	31	8	580 ap	190	390	39	2

TABLE 14.—*Names and locations of the shipping mines operating in La Salle County in 1913, and the depths, thicknesses, and elevations of the coal beds*

Name of company	Name of mine	¼	Location ¼	Sec.	T. N.	R. E.	Elevation shaft	Depth to coal	Elev. of coal	Thickness of coal	No. of bed
La Salle-Minonk field—							*Feet*	*Feet*	*Feet*	*Inches*	
Cahill Coal Co.	Cahill	SE	SW	16	33	1	463	347	116	42	2
La Salle County Carbon C. Co.	La Salle	SE	SE	15	33	1	495	395	100	42	2
La Salle County Carbon C. Co.	Union	NE	SE	16	33	1	503	386	117	48	2
La Salle County Carbon C. Co.	No. 5 (Cedar Point)	SW	SW	4	32	1	653	542	111	42	2
Oglesby Coal Co.	Oglesby	NE	SW	25	33	1	562	457	105	42	2
				..	..	..	..	300	262	60	5
				..	..	..	..	246	316	42	7
Rutland Coal Co.	Rutland	NE	SW	18	29	2	713 ap	517	196	36	2
Ottawa-Morris field—											
Gray & Jones Coal Co.		SE	NE	23	33	5	520 ap	125	395	36	2
Streator field—											
Chicago, Wilmington & Vermilion Coal Co.	No. 2	NW	SW	19	31	4	632	246	386	48	2
Chicago, Wilmington & Vermilion Coal Co.	No. 3	SW	NW	24	31	3	637	215	422	36	2

LA SALLE COUNTY

STATISTICS

COAL NO. 2

Area of the county originally underlain by coal No. 2 in square miles	590
Area of available coal, in square miles	300
Amount available in tons, average thickness, 36 inches	1,019,520,000

COAL NO. 5

Area of the county originally underlain by coal No. 5, in square miles	200
Area of available coal, in square miles	150
Amount available in tons, average thickness 36 inches	509,760,000

COAL NO. 7

Area of the county originally underlain by coal No. 7, in square miles	275
Area of available coal, in square miles	225
Amount available in tons, average thickness 36 inches	764,640,000

TOTALS FOR COUNTY

Total available original tonnage	2,293,920,000
Total already mined between 45,000,000 and 50,000,000 tons representing possibly 75,000,000,000 tons in the ground.	
Percentage already mined	3.2

Table 15 shows the output of coal of La Salle County in 1870 and 1880 and annually from 1886 to 1913, inclusive. The third column shows the production of La Salle County as compared with the total State tonnage.

TABLE 15.—*Production of coal in La Salle County since 1870 and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	173,864	...	1899	2,015,304	8.2
1880	716,487	...	1900	2,022,462	7.8
1886	980,382	8.7	1901	1,751,758	6.4
1887	1,125,235	8.9	1902	1,846,236	5.6
1888	1,090,435	7.7	1903	1,882,589	5.0
1889	1,039,703	8.5	1904	1,542,518	4.2
1890	926,214	6.0	1905	1,772,988	4.6
1891	1,378,168	7.2	1906	1,467,672	3.5
1892	1,544,311	8.6	1907	1,667,990	3.2
1893	1,494,826	7.5	1908	1,557,173	3.2
1894	1,134,097	6.6	1909	1,686,391	3.3
1895	1,084,552	6.1	1910	1,178,885	2.5
1896	1,409,085	7.1	1911	1,610,470	3.0
1897	1,508,833	7.5	1912	1,537,591	2.5
1898	1,165,490	6.2	1913	1,564,459	2.5

Drill Records and Geological Sections From La Salle County

One geological section and three drilling records from La Salle County are presented in the following pages. The section is an adaptation of that presented by H. C. Freeman in his chapter on the Geology of La Salle County in Geological Survey of Illinois, Vol. III. Some additions have been made to this section both at the top and at the bottom. The first drilling record is that of the artesian well recently sunk by the Chicago Portland Cement Co. at Oglesby, which shows the character of the strata underlying the Pennsylvanian at La Salle. The second record is that of a deep well at Streator, and the third that of a deep well east of Marseilles, which penetrates strata older than any other well in the district.

Section of the Pennsylvanian series in La Salle County (after Freeman[4] with amendations and additions by the author)

Plate IV, No. 7

Description of Strata	Thickness		Depth	
Pennsylvanian Series—	*Ft.*	*In.*	*Ft.*	*In.*
McLeansboro formation—				
Peru clays—				
Shale, reddish to bluish laminated, containing limestone nodules at the top	8	..	8	..
Clay, yellowish	8	..	16	..
Clay, blue and shaly	8	..	24	..
Coal, soft and rotten	1	..	25	..
Clay, shaly, dark, olive colored, some ocherous	11	..	36	
Limestone, argillaceous, slightly shaly	1	8	37	8
Limestone, fossiliferous and argillaceous, solid	1	6	39	2
Shale, olive black, bituminous, grayish	1	8	40	10
Limestone, marly	2	8	43	6
Coal	1	..	44	6
Fire clay	..	3	44	9
Shale, blue and brown	15	3	60	..
Shale, blue	2	..	62	..
Shale, brown	8	..	70	..
La Salle limestone—				
Limestone, gray, 7-9	9	..	79	..
Shale, blue and grayish	3	6	81	6
Limestone, gray 7-12	12	6	93	6
Shale	5	..	98	6

[4]Freeman, H. C., La Salle County: Geological Survey of Illinois, Vol. III, Chap. XIV, pp. 264-266, 1868.

Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
Limestone, blue	5	..	103	6
Black slate	7	..	110	6
Coal	..	6	111	..
Shale, blue	9	6	120	6
Limestone, blue	1	7	122	1
Shale, blue	9	3	131	4
Limestone, blue	3	5	134	9
Coal	..	1	134	10
Fire clay	..	3	135	1
Shale, blue	17	1	152	2
Limestone, gray	3	6	155	8
Shale, blue	9	6	165	2
Limestone, gray	2	6	167	8
Shale, blue	12	..	179	8
Limestone	2	..	181	8
Shale, blue	1	..	182	8
Shale, black, fissile	2	6	185	2
Shale, blue	13	..	198	2
Limestone, "marble-streaked". Lonsdale limestone (?)	4	..	202	2
Shale, blue	2	8	204	10
Limestone, blue	..	6	205	4
Shales, brownish red	2	..	207	4
Limestone	..	4	207	8
Shale, brownish red and brown	14	6	222	2
Sandstone	18	..	240	2
Shale, siliceous	19	..	259	2
Shale, slaty	11	4	270	6
Shale, black fissile	6	..	276	6
Coal No. 7, 4½ to 5 feet	4	6	281	..
Fire clay	6	..	287	..
Shale, dark colored, brownish	15	9	302	9
Sandstone	34	..	336	9
Carbondale formation—				
Shale, black, fissile	10	..	346	9
Coal No. 5, 3 and 9 feet, average 6 feet	6	..	352	9
Fire clay 2 to 4 feet	4	.	356	9
Shale, siliceous and argillaceous	30	..	386	9
Sandstone, 15′ increasing in the south and southwest part of the county to 35′ or more (Vermilionville sandstone)	35	.	421	9
Shale, blue, brown and black	9		430	9
Shale, black, fissile	2		432	9
Clay, black and greenish	1		433	9
Limestone, argillaceous	2	6	436	3
Shales, brown, and olive, with limestone	2	..	438	3

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Limestone, black, argillaceous..	..	4	438	7
Shale, black, in places blocky and carbonaceous like cannel coal	2	9	441	4
Fire clay	5	..	446	4
Shale, blue	6	..	452	4
Limestone, argillaceous	1	..	453	4
Shale, with bands of nodules...	22	..	475	4
Shale, black	1	4	476	8
Sandstone, argillaceous and calcareous	1	9	478	5
Shale, dark, septaria at the bottom	8	6	486	11
Shale, black, fissile, with nodules, spherical and oval..........	2	9	489	8
Shale, gray "soapstone"........	15	..	504	8
Coal No. 2....................	4	..	508	8
Pottsville formation—				
Fire clay, thin, sandy, 6 to 10 in.	..	10	509	6
Sandstone 3 to 6 feet...........	6	..	515	6
Shale,[5] dark gray	14	6	520	..
Shale, gray	110	..	640	..
Sandstone, white	40	..	680	..
Shale, light gray	36	..	716	..
Sandstone, gray, very fine......	10	..	726	..
Sandstone, fine, argillaceous....	10	..	736	..
Shale, bluish to greenish, sandy	25	..	761	..
Silurian system—				
Niagaran series—				
Dolomite	+	..	...	..

Log of an artesian well at Oglesby, Illinois

Well drilled in 1912 for the Chicago Portland Cement Co.

(Samples examined and interpreted by T. E. Savage)

Plate IV, No. 6

Description of Strata	Thickness *Feet*	Depth *Feet*
Pennsylvanian series—		
Shales, sandstones, limestones, coal...........	580	580
Silurian series—		
Niagaran formation—		
Limestone, gray, mixed with a small amount of drab shale and quartz sand.................	20	600
Limestone, gray, mixed with gray to dark shale	25	625
Limestone, gray, mixed with dark shale.......	5	630
Limestone, gray, slightly sandy, or sandstone, calcareous, fine	5	635

[5]Rest of the log from the record of artesian well drilled at Cedar Point.

Description of Strata	Thickness *Feet*	Depth *Feet*
Limestone, gray, finely grained	5	640
Limestone, gray, with a little sand	5	645
Limestone, gray, mixed with fragments of dark shale	5	650
Limestone, gray, mixed with dark colored fragments	30	680
Limestone, gray, fine grained	5	685
Limestone, gray, fine grained	5	690
Limestone, gray	10	700
Limestone, gray, with fragments of darker shale	5	705
Limestone, gray	5	710
Limestone, light gray, slightly dolomitic	5	715
Limestone, light gray, mixed with fragments of darker shale	10	725
Limestone, light gray	10	735
Limestone, gray, fine grained	5	740
Limestone, gray, very fine grained	75	815
Limestone, gray, subcrystalline, dolomitic	5	820
Limestone, light gray, fine grained	10	830
Limestone, white, fine grained	5	845
Limestone, gray, fine grained	5	850
Limestone, white, fine grained	15	865
Limestone, white, fine grained, subcrystalline, dolomitic	5	870
Dolomite, gray, fine grained	15	885
Dolomite, gray, subcrystalline	10	895
Dolomite, pink to red, subcrystalline	10	905
Dolomite, gray, subcrystalline	25	930
Dolomite, gray, subcrystalline, cherty	40	970
Dolomite, greenish gray	5	975
Dolomite, gray, subcrystalline	10	985
Ordovician series—		
Maquoketa formation—		
Shale, gray, calcareous	5	990
Limestone, gray, somewhat shaly	10	1000
Limestone, gray, subcrystalline	20	1020
Limestone, gray to bluish, subcrystalline Maquoketa)	20	1040
Shale, gray, rather soft	20	1060
Dolomite, gray, subcrystalline, with fragments of shale and coal	25	1085
Dolomite, gray, subcrystalline	25	1110
Limestone, gray, subcrystalline	15	1125
Shale, gray, slightly calcareous	15	1140
Shale, gray, calcareous	10	1150
Galena-Trenton formation—		
Dolomite, gray, subcrystalline	35	1185
Limestone, gray, dolomitic	40	1225
Limestone, gray, subcrystalline, slightly dolomitic	85	1310

Description of Strata	Thickness Feet	Depth Feet
Limestone, gray, subcrystalline, non-dolomitic..	55	1365
Limestone, gray, very fine grained	20	1485
Limestone, drab to gray, very fine grained	10	1495
Limestone, gray, fine grained	25	1520
Sandstone, gray (acid action slight)	10	1530
St. Peter sandstone—		
Sandstone, gray	5	1535
Sandstone, gray, round grains	10	1545
Sandstone, white, round grains	25	1570

Record of an artesian well boring at Streator, Illinois

Altitude of the surface at the well 623 feet above sea level

(Geologic interpretations by the author)

Description of Strata	Thickness Feet	Depth Feet
Pleistocene and recent series—		
Drift	30	30
Pennsylvanian series —		
Shales, limestone, sandstone, and coal	211	241
Ordovician system—		
Galena-Trenton formation—		
Limestone	203	444
St. Peter sandstone	225	669
Lower Magnesian formation—		
Limestone, white	90	759
Sandstone, white	133	892
Limestone, white	211	1103
Sandstone, white	37	1140
Limestone, dark gray	50	1190
Sandstone, fine, reddish (contained magnetic iron grains)	15	1205
Limestone, dark gray	13	1218
Sandstone, white and brown, mixed	1	1219
Limestone, gray	18	1237
Sandstone, white with some brown	168	1405
Cambrian system—		
Shale, blue	100	1505
Limestone, dark	73	1578
Sandstone, dirty brown	21	1599
Sandstone, limy and shaly	2	1601
Sandstone, buff	35	1636
Sandstone, white to buff	77	1713
Sandstone, white	25	1738
Sandstone, red (grains of magnetic iron)	10	1748
Sandstone, dirty brown (10% mag. iron)	17	1765
Lime, soft	60	1825
Shale, blue	13	1838
Shale, brown, sandy, hard	30	1868
Shale, blue, soft	20	1888

Shale, pink	95	1983
Sandstone, dark red	80	2063
Shale, blue	50	2113
Limestone, bluish	50	2163
Cambrian system—		
Potsdam sandstone—		
Sandstone, dark drab	15	2179
Sandstone, reddish buff	35	2213
Sandstone, white	283	2496

Record of an artesian well drilled on the farm of R. N. Peddicord in the SW. ¼ NE. ¼ sec. 32, T. 34 N., R. 5 E., near Marseilles, La Salle County

Elevation of the surface about 710 feet above sea level

(Geologic interpretations by the author)

Description of Strata	Thickness *Feet*	Depth *Feet*
Pleistocene and recent—		
Soil and drift	165	165
Pennsylvanian series—		
Shale (till ?)	9	174
Sandstone	8	182
Shale	10	192
Shale, hard	7	199
Sandstone (sand and gravel)	70	269
Shale	65	334
Ordovician system—		
Trenton limestone	25	359
St. Peter sandstone	195	554
Lower Magnesian formation—		
Sandstone, calciferous	50	604
Sandstone	45	649
Limestone	265	914
Sandstone, calciferous	25	939
Limestone	72	1011
Sandstone, hard	15	1026
Limestone	95	1121
Shale, blue	73	1194
Limestone	34	1228
Shale	3	1231
Limestone	20	1251
Cambrian system—		
Sandstone	15	1266
Sandstone, white	265	1531
Limestone	152	1683
Shale, blue	50	1733
Shale, red	5	1738
Shale, blue	60	1798
"Slate"	112	1910
Shale	9	1919
Limestone	20	1939
Sandstone	214	2153
Limestone	5	2158
Sandstone	125	2283

LIVINGSTON COUNTY

Statistics

No attempt has been made to estimate the amount of surface underlain by coal in that part of Livingston County lying within the Longwall District because of the very uncertain character of the distribution of the coal.

There were no commercial mines operating in 1913 in that part of Livingston County that lies in the Longwall District.

Table 16 shows the output of coal of Livingston County in 1870 and 1880 and annually from 1886 to 1913, inclusive. The third column shows the production of Livingston County as compared with the total tonnage of the State.

Table 16.—*Production of coal in Livingston County since 1870 and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	49,360	1.8	1899	129,484	.5
1880	118,230	1.9	1900	236,872	.9
1886	208,545	1.8	1901	307,267	1.1
1887	387,600	3.1	1902	395,083	1.1
1888	495,388	3.4	1903	122,773	.3
1889	383,965	3.1	1904	186,688	.5
1890	372,504	2.4	1905	284,984	.7
1891	404,491	2.5	1906	273,831	.6
1892	532,667	2.9	1907	303,497	.5
1893	542,516	2.7	1908	265,666	.5
1894	342,127	1.9	1909	246,031	.4
1895	267,133	1.5	1910	162,898	.3
1896	218,953	1.1	1911	89,423	.1
1897	145,206	.7	1912	65,774	.1
1898	122,087	.6	1913	63,877	.1

Drill Records From Livingston County

Two records of drilling from Livingston County are given. The first is that of a diamond drill record in the vicinity of Cardiff penetrating the underlying Silurian, the second is that of an artesian well at Dwight, showing Pennsylvanian, Silurian, and Ordovician strata.

Record of a diamond drill boring in the vicinity of Cardiff, Illinois

Elevation about 635 feet above sea level. Drilled in 1898

(Geologic interpretations by the author)

Plate IV, No. 3

Description of Strata	Thickness		Depth	
Pleistocene and recent series—	*Ft.*	*In.*	*Ft.*	*In.*
Soil, black	2	..	2	
Clay, sandy	5	..	7	..
Clay, pebbly	7	..	14	..
Clay, blue, full small gravel	46	..	60	..
Sand and gravel	3	..	63	..
Sand and gravel	2	..	65	..
Clay, blue	6	..	71	..
Gravel	2	..	73	..
Clay, hard, blue	9	..	82	..
Sand and gravel	1	..	83	..
Blue clay and gravel	2	..	85	..
Limestone boulder	..	5	85	5
Hardpan	1	7	87	..
Hardpan	8	..	95	..
Sand	3	..	98	..
Clay	1	..	99	..
Sand and gravel	13	..	112	..
Sand and gravel	15	..	127	..
Sand and gravel	4	..	131	..
Pennsylvanian series—				
McLeansboro and Carbondale formations—				
Shale, soft, blue	6	..	137	..
Shale, blue	1	6	138	6
Shale, black	2	..	140	6
Fire clay	6	..	146	6
Fire clay	6	6	153	..
Shale, black	2	6	155	6
Shale, soft, light	..	7	156	1
Coal	..	10	156	11
Shale, dark	1	1	158	..
Fire clay	9	..	167	..
Shale, sand	24	..	191	..
Shale, dark sand	10	..	201	..
Shale, gray	20	..	221	..
Shale, hard, dark blue	9	..	230	..
Coal, good	1	10	231	10
Shale, black, mixed with coal	1	2	233	..
Shale, light	..	4	233	4
Slate, black, mixed with coal	1	..	234	4
Fire clay	2	8	237	..
Shale, dark, soft	2	..	239	..
Shale, light, soft	3	..	242	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Limestone	2	..	244	..
Shale, dark	2	..	246	..
Coal stone (coal No. 2)	..	8	246	8
Shaly coal	..	4	247	..
Soapstone	..	8	247	8
Coal	..	2	247	10
Pottsville formation—				
Shale, brown	1	2	249	..
Limestone, sandy	2	..	251	..
Limestone	2	..	253	..
Sandstone	3	..	256	..
Rock, hard, dark	1	..	257	..
Shale, light	17	..	274	..
Shale, black	4	..	278	..
Coal	..	5	278	5
Shale, light sand	2	7	281	..
Limestone	2	..	283	..
Shale, light sand	1	..	284	..
Conglomerate	3	..	287	..
Silurian system—				
Niagara (?) limestone—				
Limestone	23	..	310	..

Record of an artesian well at Dwight, Ill., bored in 1912

Well owned by Leslie Keely

(Geologic interpretation by author)

Plate IV, No. 4

Description of Strata	Thickness *Feet*	Depth *Feet*
Pleistocene and recent series—		
Gravel, clay and sand	157	157
Pennsylvanian series—		
Shale	44	201
Limestone	3	204
Shale	36	240
Coal (and shale ?) coal No. 2 (?)	10	250
Shale	45	295
Silurian and Ordovician systems—		
Niagaran or Maquoketa limestone	53	348
Maquoketa shale	61	409
Galena-Trenton limestone	386	795
St. Peter formation—		
Sandstone	251	1046
Shale	9	1055
Lower Magnesian limestone	22	1077

MARSHALL COUNTY (EAST OF ILLINOIS RIVER)

STATISTICS

COAL NO. 2

Area of the county originally underlain by coal No. 2, in square miles	240
Area of available coal, in square miles	240
Amount available in tons, average thickness 36 inches	815,616,000

COAL NO. 5

Area of the county originally underlain by coal No. 5, in square miles	115
Area of available coal, in square miles	60
Amount available in tons, average thickness 36 inches	203,904,000

COAL NO. 7

Area of the county originally underlain by coal No. 7, in square miles	90
Area of available coal, in square miles	60
Amount of available coal in tons, average thickness, 36 inches	203,904,000

TOTALS FOR COUNTY

Total tonnage originally available	1,223,424,000
Total amount mined east of Illinois River is the product of two mines, practically negligible, less than	0.1

Table 17 shows the production of coal in Marshall County in 1870 and 1880 and annually from 1886 to 1913, inclusive. The third column shows the relative production of the county as compared with the total State tonnage.

TABLE 17—*Production of coal in Marshall County in 1870, and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	17,330	.6	1899	350,732	1.4
1880	9,536	.4	1900	396,087	1.5
1886	56,174	.5	1901	417,444	1.5
1887	73,928	.5	1902	448,186	1.3
1888	87,013	.6	1903	479,641	1.2
1889	59,784	.4	1904	467,724	1.2
1890	56,574	.3	1905	499,672	1.3
1891	65,219	.4	1906	418,904	1.0
1892	78,576	.4	1907	482,796	.9
1893	92,144	.4	1908	393,281	.8
1894	134,696	.7	1909	295,812	.5
1895	346,281	1.9	1910	267,447	.5
1896	389,429	1.9	1911	423,984	.7
1897	339,820	1.6	1912	449,660	.7
1898	286,365	1.5	1913	426,490	.6

DRILL RECORDS FROM MARSHALL COUNTY

Three drill records from Marshall County are presented. The first shows especially the Pottsville and some of the underlying strata

TABLE 18—*Names and locations of the shipping mines operating in Marshall County in 1913, and the depths, thicknesses, and elevations of the coal beds*

Name of company	Name of mine	Location					Elevation shaft	Depth to coal	Elev. of coal	Thickness of coal	No. of bed
		¼	¼	Sec.	T. N.	R. E.					
							Feet	*Feet*	*Feet*	*Inches*	
Wenona Coal Co.		..	NE	13	30	1	696 ap	567	129	40	2
		..	..	..	..	..	..	absent	..	..	5
		..	..	..	..	..	..	332	364	40	7
Toluca Coal Co.	No. 2	E½	NE	8	29	1	702 ap	507	195	34	2
		..	..	..	..	..	..	450	352 ap	24	5
		..	..	..	..	..	..	410	392 ap	38	7

TABLE 19.—*Names and locations of the shipping mines operating in Putnam County in 1913, and the depths, thicknesses, and elevations of the coal beds*

Name of company	Name of mine	Location					Elevation shaft	Depth to coal	Elev. of coal	Thickness of coal	No. of bed
		¼	¼	Sec.	T. N.	R.W.					
							Feet	*Feet*	*Feet*	*Inches*	
B. F. Berry Coal Co.	Standard	SE	SE	11	32	1	680	497	183	36	2
		..	..	..	..	..	ap	321	359	6	5
		..	..	..	..	..	..	284	396	36	7
St. Paul Coal Co.	Granville	NW	NE	8	32	1	678	454	224	36	2
		..	..	..	..	..	..	260	418	36	5
		..	..	..	..	..	..	225	453	42	7

TABLE 22.—*Names and locations of the shipping mine operating in Woodford County in 1913, and the depths, thicknesses, and elevations of the coal beds*

Name of company	Name of mine	Location					Elevation shaft	Depth to coal	Elev. of coal	Thickness of coal	No. of bed
		¼	¼	Sec.	T. N.	R. E.					
		..	..				Feet	*Feet*	*Feet*	*Inches*	
Minonk Coal Co.	No. 2	NE	NW	7	28	1	751 ap	537	214	36	2
		..	..	..	..	..	..	..	..	..	5
		..	..	..	..	..	..	370	381	2	7

on the east side of Illinois River opposite Henry. This is followed by the record of a boring near Toluca that shows the strata down to the fire clay below coal No. 2. The third shows the character of the strata near Sparland, down to a coal, possibly No. 2.

Record of drilling in T. 30 N., R. 2 W., Marshall County, across the Illinois River from Henry

Elevation of surface 458 feet above sea level.

Details above coal No. 2, obscured

(Geologic interpretation by the author)

Plate IV, No. 12

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene and recent series—				
Soil and drift	73	..	73	..
Pennsylvanian series—				
Carbondale formation—				
Shale, limestone and coal (No. 2)	98	4	171	4
Pottsville formation—				
Fire clay	4	..	175	4
Shale, blue	25	8	201	..
Shale, sandy	9	..	210	..
Sandstone	23	..	233	..
Slate, black	..	6	233	6
Fire clay	2	..	235	6
Shale, light	15	6	251	..
Slate, black	..	8	251	8
Coal No. 1 (?)	..	10	252	6
Fire clay	1	6	254	..
Shale, light	5	..	259	..
Slate, dark	6	6	265	6
Slate, black	..	6	266	..
Fire clay	3	..	269	..
Shale, sandy	2	..	271	..
Sandstone	8	..	279	..
Devonian system (?)—				
Shale, brown	36	..	315	..
Shale, lime	2	..	317	..
Shale, brown	20	..	337	..
Shale blue	5	..	342	..
Shale, dark	4	..	346	..
Shale, blue	1	..	347	..
Silurian system (?)—				
Niagaran formation—				
Limestone, gray and hard	11	..	358	..
Limestone, soft	19	..	377	..
Shale, light	1	6	378	6
Limestone, hard	1	6	380	..

Log of diamond drilling for coal in the NE. ¼ NE. ¼ sec. 5, T. 29 N., R. 1 W. near Toluca, Marshall County, Illinois

Hole drilled in 1892

(Geologic interpretation by author)

Plate IV, No. 10

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Pleistocene and recent series—				
Soil	1	..	...	..
Boulder clay	5	..	6	..
Gray	39	..	44	..
Sand (water)	12	..	51	..
Gravel (water)	5	..	56	..
Gravel and sand	3	..	59	..
Gray clay	3	..	62	..
Gravel and clay	5	..	67	..
Gravel and sand	12	..	79	..
Gravel and clay	12	..	91	..
Sand and gravel	8	..	99	..
Gravel and clay	15	..	114	..
Pennsylvanian series—				
McLeansboro and Carbondale formations—				
Shale, gray	16	..	130	..
Limestone	5	..	135	..
Clay, red	3	..	138	..
Shale, dark	4	..	142	..
Clay	3	..	145	..
Clay, red	3	..	148	..
Clay, gray	2	..	150	..
Clay, dark	3	..	153	..
Fire clay	4	..	157	..
Shale, dark	2	..	159	..
Shale, light	6	..	165	..
Clay, gray	2	..	167	..
Shale, light	4	..	171	..
Shale, gray	5	..	176	..
Shale, dark	2	..	178	..
Clay	1	..	179	..
Shale, light gray	10	6	189	6
Sandstone	48	6	238	..
Shale	15	..	253	..
Shale, dark	25	..	278	..
Slate, black	..	6	278	6
Shale	9	6	288	..
Coal No. 7	3	6	291	6
Clay	7	6	299	..
Sandstone	14	..	313	..
Shale	5	..	318	..
Limestone	3	..	321	..

Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
Slate, black	10	..	331	..
Coal No. 5	1	6	332	6
Clay	5	6	338	..
Sandstone	8	..	346	..
Shale, sand	15	..	361	..
Shale, sandy	34	..	395	..
Shale, dark	6	..	401	..
Shale, black	3	6	404	6
Limestone	3	6	408	..
Shale, dark	16	..	424	..
Shale, black	4	..	428	..
Coal	1	..	429	..
Fire clay	6	..	435	..
Shale, sandy	16	..	451	..
Shale, gray	2	..	453	..
Shale, dark	3	..	456	..
Sandstone	13	..	469	..
Shale (?)	32	6	501	6
Coal, No. 2	2	6	504	..
Clay	2	6	506	6

Record of a drilling for coal near Sparland, Marshall County, in sec. 22 T. 12 N., R. 9 E.*

Drilled, August, 1910

(Geologic interpretations by the author)

Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
Pleistocene and recent series—				
Clay	17	..	17	..
Gravel, sand, and till	51	4	68	4
Gravel	4	..	72	4
Till, blue	3	..	75	4
Sand and gravel	5	..	80	4
Pennsylvanian series—				
McLeansboro formation—				
Shale, light gray	23	4	103	8
Sandstone	1	3	104	11
Shale, light gray	2	3	107	2
Shale, dark gray	15	1	122	3
Sandstone	2	..	124	3
Shale, dark gray	21	7	145	10
Shale, black	2	4	148	2
Coal, soft, dirty (No. 7 ?)	2	6	150	8
Clay	2	9	153	5
Shale, lime	2	10	156	3
Sandstone	7	1	163	4

*Log presented by the Barr Coal, Lumber, and Power Co.

Description of Strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Sandshale, limy	9	..	172	4
Shale, dark	..	8	173	..
Carbondale and Pottsville formations—				
Coal No. 6	2	4	175	4
Clay	..	4	175	8
Coal	..	11	176	7
Clay	2	..	178	7
Shale, light	14	2	192	9
Shale, gray sand	14	.	206	9
Shale, light sand	3	2	210	11
Shale, dark gray	33	1	244	..
Shale, gray	..	6	244	6
Shale, black	2	.	246	6
Slate, black	2	9	249	3
Coal	..	5	249	8
Clay	1	6	251	2
Shale, light	3	1	254	3
Shale, dark	2	6	256	9
Shale, light	5	..	261	9
Sandstone	1	6	263	3
Shale, light gray	8	10	272	1
Sandstone	9	..	281	1
Shale, light gray	1	2	282	3
Sandstone	3	1	285	4
Shale, light	10	8	296	..
Sandstone	3	..	299	..
Shale, gray sand	4	2	303	2
Shale, gray	13	..	316	2
Shale, light gray	28	..	344	2
Shale, blue	10	..	354	2
Shale, light gray	6	10	361	..
Shale, black (No. 2 ?)	2	4	363	4
Shale, light gray	12	8	375	..
Shale, light	21	..	396	..

PUTNAM COUNTY

STATISTICS

COAL NO. 2	Approximate
Area of the county originally underlain by coal No. 2, in square miles	172
Area of available coal, in square miles	132
Amount available in tons, average thickness 36 inches	448,588,000

COAL NO. 5	
Area of the county originally underlain by coal No. 5, in square miles	84
Area of available coal, in square miles	40
Amount available in tons, average thickness 36 inches	135,936,000

COAL NO. 7	
Area of the county originally underlain by coal No. 7, in square miles	72
Area of available coal, in square miles	50
Amount available in tons, average thickness 36 inches	169,920,000

TOTALS FOR COUNTY	
Total tonnage originally available	754,444,000
Total tonnage already mined (1913)	3,441,414
Percentage already mined	.45

A list of mines for Putnam County is given in Table 19, page 134.

Table 20 shows the output of coal for Putnam County since the beginning of production in 1906 to 1913, inclusive. The third column shows the relative production of the county as compared with the total State tonnage.

TABLE 20.—*Production of coal in Putnam County since 1906, and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1906	156,928	.3	1910	364,882	.7
1907	362,858	.7	1911	772,976	1.4
1908	466,019	.9	1912	720,048	1.2
1909	597,703	1.1	1913	......	...

Drill Records From Putnam County

Only one record of drilling from Putnam County is given, the log of the B. F. Berry Coal Co. shaft, at Standard, Illinois.

Record of the shaft of the B. F. Berry Coal Co., Standard, Putnam County, Illinois

Surface elevation about 680 feet above sea level

(Geologic interpretations by the author)

Plate IV, No. 9

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Previous drilling	84	..	84	..
Pleistocene and recent series—				
Clay, red	5	..	89	..
Clay, red mixed with sand	6	5	95	5
Silt, light green, mixed with sand	3	11	99	4
Pennsylvanian series—				
McLeansboro and Carbondale formations—				
Shale, lime	9	3	108	7
Limestone	5	..	113	7
Shale, black	4	..	117	7
Shale, gray	2	7½	120	2½
Fire clay with a little coal	3	9½	124	..
Fire clay	4	..	128	..
Fire clay and hardpan	2	6	130	6
Shale, lime, with streaks of hardpan	7	6	138	..
Shale, blue, and lime	2	..	140	..
Limestone and gray shale	3	..	143	..
Shale, gray	7	..	150	..
Shale, lime, and boulders	4	..	154	..
Shale, blue	4	..	158	..
Conglomerate	4	..	162	..
Shale, blue	2	8	164	8
Clay, hard	9	8	174	4
Shale, blue	4	..	178	4
Shale, gray	4	6	182	10
Shale, gray and blue	10	6	193	4
Fire clay	6	..	199	4
Shale, lime	2	..	201	4
Lime rock	2	..	203	4
Conglomerate	2	..	205	4
Shale	3	..	208	4
Clay, hard	8	6	216	10
Conglomerate	1	..	217	10
Sand-shale	13	10	231	8
Conglomerate	2	..	233	8

Description of Strata	Depth		Thickness	
	Ft.	*In.*	*Ft.*	*In.*
Sandstone	4	2	237	10
Sand and shale, blue	3	..	240	10
Sand-shale	12	6	253	4
Shale, light	9	7	262	11
Shale, gray	2	1	265	..
Shale, dark	19	..	284	..
Coal No. 7	3	..	287	..
Fire clay	11	4	298	4
Sand-shale	15	8	314	..
Limestone, blue shale, and slate, black	7	4	321	4
Coal No. 5	..	6	321	10
Fire clay	3	4	325	2
Sandstone	12	4	337	6
Sand-shale	16	6	354	..
Sand-shale mixed with gray	34	10	388	10
Shale, gray	12	4	401	2
Shale, blue	3	10	405	..
Shale, black	9	..	414	..
Shale, light	4	10	418	10
Shale, dark, and ironstone	3	..	421	10
Hardstone, mixed with lime	4	..	425	10
Shale, dark	4	2	430	..
Shale, lime, and boulders	4	..	434	..
Fire clay and boulders	2	..	436	..
Sandstone	6	8	442	8
Shale, sand	12	4	455	..
Shale, gray	12	3	467	3
Shale, gray with sulphur balls	8	9	476	..
Shale, black, and "niggerheads"	5	..	481	..
Shale, light	16	7¼	497	7¼
Coal, No. 2	3	..	500	7¼
Pottsville formation—				
Fire clay	1	3	501	10¼
Sandstone	4	..	505	10¼
"Soapstone"	10	..	515	10¼

WILL COUNTY

Statistics (Approximate)

COAL NO. 2

Area of the county originally underlain by coal No. 2, in square miles 27
Area of available coal, in square miles.............................. 20
Amount available in tons, average thickness 30 inches............... 56,640,000

COAL NO. 5

Area of the county underlain by coal No. 5, in square miles.......... 0

COAL NO. 7

Area of the county underlain by coal No. 7, in square miles.......... 0

TOTALS FOR COUNTY

Total tonnage originally available................................. 56,640,000
Total tonnage mined between 7,000,000 and 8,000,000, representing 10,000,000 tons in the ground.
Percentage already mined.. 17.6

The coal produced in Will County during 1913 was from three small mines operated by the following companies:

Murphy, Linsky & Kasher Coal Co. (Murphy mine).

Oswald & Young (No. 1 mine).

Wilmington Coal Mining and Manufacturing Co. (Diamond No. 6).

Table 21 shows the output of coal of Will County in 1870 and 1880 and annually from 1886 to 1913 inclusive. The third column shows the relative production of the county as compared with the total State tonnage.

TABLE 21.—*Production of coal in Will County since 1870, and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	228,000	8.6	1899	42,275	.1
1880	984,908	16.1	1900	55,323	.2
1886	287,512	2.5	1901	56,646	.2
1887	284,040	2.2	1902	40,792	.1
1888	347,105	2.4	1903	49,240	.1
1889	342,372	2.8	1904	76,538	.2
1890	288,131	1.8	1905	137,957	.3
1891	233,613	1.5	1906	154,955	.3
1892	113,847	.6	1907	183,985	.3
1893	81,725	.4	1908	162,239	.3
1894	20,717	.1	1909	162,307	.3
1895	38,675	.2	1910	124,652	.2
1896	86,950	.4	1911	178,397	.3
1897	25,682	.2	1912	130,806	.2
1898	40,904	.2	1913	149,926	.2

Drill Records From Will County

The record of the well at Braidwood is selected as representative of the Will County section.

Record of artesian well at Braidwood, Will County, Illinois, drilled in 1889
(Geologic interpretations in part by the author)

Plate IV, No. 1

Description of Strata	Thickness		Depth.	
Pleistocene and recent series—	*Ft.*	*In.*	*Ft.*	*In.*
Sand	15	..	15	..
Clay, (hardpan)	6	6	21	6
Clay and boulders	12(?)	6	34	..
Pennsylvanian series—				
Carbondale formation—				
Shale, clay	3	..	37	..
Sandstone	10	..	47	..
Shale (slate)	4	..	51	..
Shale	29	..	80	..
Coal No. 2	2	9	82	9
Pottsville formation—				
Fire clay	3	3	86	..
Sandstone	6	..	92	..
Shale ("slate")	1	..	93	..
Coal	..	6	93	6
Shale	13	6	107	..
Sandstone	8	6	115	6
Shale, bituminous	6	..	116	6
Fire clay	2	..	118	..
Fire clay, nodular	2	..	120	..
Shale	3	..	123	..
Coal	..	6	123	6
Fire clay	1	6	125	..
Shale, sandy	12	..	140	..
Silurian series—				
Niagaran (?) limestone	46	..	186	..
Ordovician series—				
Cincinnatian limestone and shale—				
Shale	2	..	188	..
Limestone	35	..	223	..
Limestone and shale	10	..	233	..
Shale, gray	20	..	253	..
Shale, hard and soft	15	..	268	..
Galena-Trenton limestone	377	..	645	..
St. Peter sandstone	208	..	853	..
Lower Magnesian limestone—				
Limestone	5	..	858	..
Sandstone	2	..	860	..
Limestone	40	..	900	..

WOODFORD COUNTY

The shipping mine of Woodford County is given in Table 22, page 134.

Table 23 shows the output of coal in Woodford County in 1870 and 1880 and annually from 1887 to 1913, inclusive. The third column shows the relative production of the county as compared with the total State tonnage.

TABLE 23.—*Production of coal in Woodford County since 1870 and a comparison with the total output of the State*

Calendar Year	Quantity Tons	Percentage of State Production	Calendar Year	Quantity Tons	Percentage of State Production
1870	4,000	.1	1899	179,024	.7
1880	175,000	2.8	1900	192,135	.7
1886	......	...	1901	142,219	.5
1887	122,445	.9	1902	101,567	.3
1888	154,500	1.1	1903	123,501	.3
1889	169,600	1.4	1904	105,185	.2
1890	129,724	.8	1905	348,707	.9
1891	140,820	.7	1906	717,566	1.7
1892	158,041	.8	1907	158,742	.3
1893	180,131	.9	1908	174,031	.3
1894	156,665	.9	1909	194,410	.3
1895	131,557	.7	1910	125,823	.2
1896	162,790	.8	1911	164,001	.3
1897	148,829	.7	1912	185,499	.3
1898	145,840	.7	1913	......	...

SUMMARY FOR LONGWALL DISTRICT

Table 24 presents a summary of preceding pages and shows the estimated original coal and the total extraction and wastage.

TABLE 24.—*Coal supplies in the counties of the Longwall District and the total amount of coal mined to date*

	Original Coal supply *Tons*	Coal mined or made unavailable by mining *Tons*
Bureau	713,664,000	25,000,000
Grundy	849,600,000	40,000,000
Kankakee	84,960,000	3,000,000
La Salle	2,293,920,000	75,000,000
Livingston	....	....
Marshall	1,223,424,000	7,000,000
Putnam	754,444,000	4,000,000
Will	56,640,000	8,000,000
Woodford	....	....
Total	5,976,652,000	
Total (2.7% of supply)		162,000,000

Total production of State (1913), 61,618,744 tons.

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Bulletin 1. Preliminary Report on Organization and Method of Investigations, 1913.

Bulletin 2. Coal Mining Practice in District VIII (Danville), by S. O. Andros, 1914.

Bulletin 3. A Chemical Study of Illinois Coals, by Prof. S. W. Parr, (in press).

Bulletin 4. Coal Mining Practice in District VII (Mines in bed 6 in Bond, Clinton, Christian, Macoupin, Madison, Marion, Montgomery, Moultrie, Perry, Randolph, St. Clair, Sangamon, Shelby, and Washington counties), by S. O. Andros, 1914.

Bulletin 5. Coal Mining Practice in District I (Longwall), by S. O. Andros, 1914.

Bulletin 6. Coal Mining Practice in District V (Mines in bed 5 in Saline and Gallatin counties), by S. O. Andros, 1914.

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Bulletin 8. Coal Mining Practice in District VI (Mines in bed 6 in Franklin, Jackson, Perry, and Williamson counties), by S. O. Andros, 1914.

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Bulletin 10. Coal Resources of District I (Longwall), by G. H. Cady, 1915.

Bulletin 11. Coal Resources of District VII (Counties listed in Bulletin 4), by Fred H. Kay, 1915.

*Bulletin 72. U. S. Bureau of Mines, Occurrence of Explosive Gases in Coal Mines, by N. H. Darton, 1915.

*Bulletin 83. U. S. Bureau of Mines, The Humidity of Mine Air, with Especial Reference to Coal Mines in Illinois, by R. Y. Williams, 1914.

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* Copies of these bulletins may be obtained by addressing the Director, U. S. Bureau of Mines, Washington, D. C.

BULLETIN OF

ILLINOIS COAL MINING INVESTIGATIONS

COOPERATIVE AGREEMENT

State Geological Survey
Department of Mining Engineering, University of Illinois
U. S. Bureau of Mines

BULLETIN 11

Coal Resources

OF

District VII

(Coal No. 6 West of Duquoin anticline)

BY

FRED H. KAY

Field Work by K. D. White, Fred H. Kay, and others

In cooperation with
U. S. Geological Survey

STATE GEOLOGICAL SURVEY
UNIVERSITY OF ILLINOIS
URBANA
1915

The Forty-seventh General Assembly of the State of Illinois, with a view of conserving the lives of the mine workers and the mineral resources of the State, authorized an investigation of the coal resources and mining practices of Illinois by the Department of Mining Engineering of the University of Illinois and the State Geological Survey in cooperation with the United States Bureau of Mines. A cooperative agreement was approved by the Secretary of the Interior and by representatives of the State of Illinois.

The direction of this investigation is vested in the Director of the United States Bureau of Mines, the Director of the State Geological Survey, and the Head of the Department of Mining Engineering, University of Illinois, who jointly determine the methods to be employed in the conduct of the work and exercise general editorial supervision over the publication of the results, but each party to the agreement directs the work of its agents in carrying on the investigation thus mutually agreed on.

The reports of the investigation are issued in the form of bulletins, either by the State Geological Survey, the Department of Mining Engineering, University of Illinois, or the United States Bureau of Mines. For copies of the bulletins issued by the State and for information about the work, address Coal Mining Investigations, University of Illinois, Urbana, Ill. For bulletins issued by the United States Bureau of Mines, address Director, United States Bureau of Mines, Washington, D. C.

ILLINOIS
COAL MINING INVESTIGATIONS
COOPERATIVE AGREEMENT

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Department of Mining Engineering, University of Illinois
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FIG. 1.—Map showing area covered in the report.

COAL RESOURCES OF DISTRICT VII

By Fred H. Kay

PART I—GEOLOGIC RELATIONS IN DISTRICT VII

INTRODUCTION

IMPORTANCE OF THE AREA

This report covers 7000 square miles in southwestern Illinois, including all or parts of the following counties: Sangamon, Christian, Montgomery, Macoupin, Bond, Madison, Shelby, Moultrie, Fayette, St. Clair, Clinton, Marion, Washington, Perry, and Randolph. (See figure 1). The area described contained originally 46,279,496,000 tons of coal in bed No. 6. From 1881 to June 30, 1913, inclusive, approximately 347,106,000 tons of this coal were mined in this area. Since only 55 per cent of the coal is recovered in this district[1] about 283,996,000 tons were left in the mines as pillars and will probably never be extracted. The total amount of coal mined and rendered unavailable is then 631,102,000 tons, leaving in the district 45,648,394,000 tons of coal No. 6. At the present rate of consumption and with only a 55 per cent recovery, coal No. 6 alone in District VII could supply the entire demand for bituminous coal in the United States for almost 100 years. The rate of consumption is however increasing very rapidly.

In view of the importance of the coal deposits, the State Geological Survey, in cooperation with the Department of Mining Engineering of the University of Illinois and the U. S. Bureau of Mines, undertook in 1912 to prepare a series of bulletins dealing with the coal resources of the State. The present report for District VII treats that part of southwestern Illinois underlain by coal No. 6 in commercial thickness. This bed underlies practically the entire area and presents reasonably uniform conditions for study. The other districts examined by the Investigation are listed in a previous publication.[2]

[1]Andros, S. O., Coal Mining Practice in District VII; Ill. Coop. Mining Invest., Bull. 4, vol. I, No. 1, May 1914, p. 17.

[2]Prelim. Bull. Illinois Coal Mining Investigations, p. 12, 1913.

Acknowledgments

A large amount of the material embodied in this report is derived from the notes of other workers, especially those of K. D. White, who rendered most valuable assistance during the field work of 1912, and later in the compilation of material in the office. Mr. White visited a large number of the mines selected for examination, and his carefully prepared notes have been of great value in the preparation of the report. The notes of J. A. Udden, G. H. Cady, F. F. Grout, W. F. Wheeler, Thos. Moses, and others have been used freely.

Grateful acknowledgment is made for the use of Mr. Udden's report on the Belleville-Breese area published in Bulletin 8 of the Geological Survey in cooperation with the U. S. Geological Survey. The report on the "Carlyle Oil Field and Surrounding Territory" by E. W. Shaw, of the U. S. Geological Survey in cooperation with the Illinois State Geological Survey has been of great service to the author and has been quoted in a number of places.

Since the field work for the report was completed, Wallace Lee, of the U. S. Geological Survey, cooperating with the State Geological Survey, has made a detailed study of the Gillespie-Mt. Olive quadrangles, and his report will be published as a folio of the geological atlas of the U. S. by the Federal Survey. Mr. Lee has kindly made useful suggestions regarding details in the region examined by him.

Through the uniform kindness and generosity of a large number of operators, investors, and mining men, hundreds of drill records have been made available for study, and all of the mines have been opened without reserve to representatives of the Investigation. A. J. Moorshead, General Manager, and G. E. Lyman, Mining Engineer, Madison Coal Corporation, have been most generous in furnishing information regarding the district and in supplying many excellent underground photographs. The Fischer Fuel Company of St. Louis, through Mr. B. W. Hilgard, have kindly furnished photographs of their stripping mine at Millstadt. Special thanks for favors are due F. S. Peabody, Peabody Coal Company, who has not only furnished a great deal of information but also kindly consented to read this report in manuscript form and offered many helpful suggestions. F. H. Brown, H. S. Hargrave, and A. W. Crawford, of Hillsboro, have given unstinted assistance in many ways. Mr. Thomas Jeremiah furnished valuable information regarding the position of the coal outcrop in Perry and Randolph counties.

Throughout the investigation and the preparation of the report the author has received the hearty cooperation and the helpful suggestions of F. W. DeWolf, Director of the Illinois Geological Survey, under whose general direction the work has been carried on.

Topography and Drainage

The area is an undulating plain which slopes gently south and west except in the area southeast of Springfield, which is drained by tributaries of Sangamon River.

Except the territory drained by South Fork of Sangamon River, the entire area drains southwest. Macoupin and Shoal creeks, Kaskaskia River, and the tributaries of Big Muddy constitute the principal streams traversing the district. The streams are sluggish throughout the greater part of their courses and do not cut deep valleys, although near the Illinois and the Mississippi, which receive all the drainage of the area, some of the valleys show a relief of 200 feet. Along the divide which extends in a general north-south direction in the eastern part of the district, the surface reaches an elevation of 700 feet above sea level, or 400 feet above the river at St. Louis. For some distance on both sides of the rivers the topography is rugged, and farm land is restricted to the flood plains and the divides between the streams.

A network of railroad lines covers the southwestern part of Illinois and places it in close touch with Chicago, St. Louis, and the markets of the northwest.

Use of Drill Records

For the most part the drill records studied in the preparation of the report are copies of the logs kept by the drillers, but frequently it has been possible to arrange for the saving of samples from each screw for identification by the Survey. Figure 2 is a photograph of the heavy paper sacks that are furnished by the Survey for the purpose. The driller catches some of the material brought up by the bailer after each screw and places it in a sack which is properly marked as to depth. After 40 or 50 sacks have been filled, they are forwarded to the Geological Survey, Urbana, by express collect.

Some of the formations are identifiable only by fossils known to men of experience in this line of work. The identification is rendered more difficult in drillings, because only fragments of the rocks and fossils are available. It is highly desirable, therefore, that operators arrange for such a study as outlined in connection with any contemplated drilling operations. Diamond-drill cores are the best means of studying the formations in a drift-covered area like Illinois, and through the kindness of the operators, it has been possible for the Survey to secure such cores from a number of places for examination in the office.

The fact that every inch of the beds is represented in a core renders identifications and measurements far more satisfactory than in churn-drill cuttings.

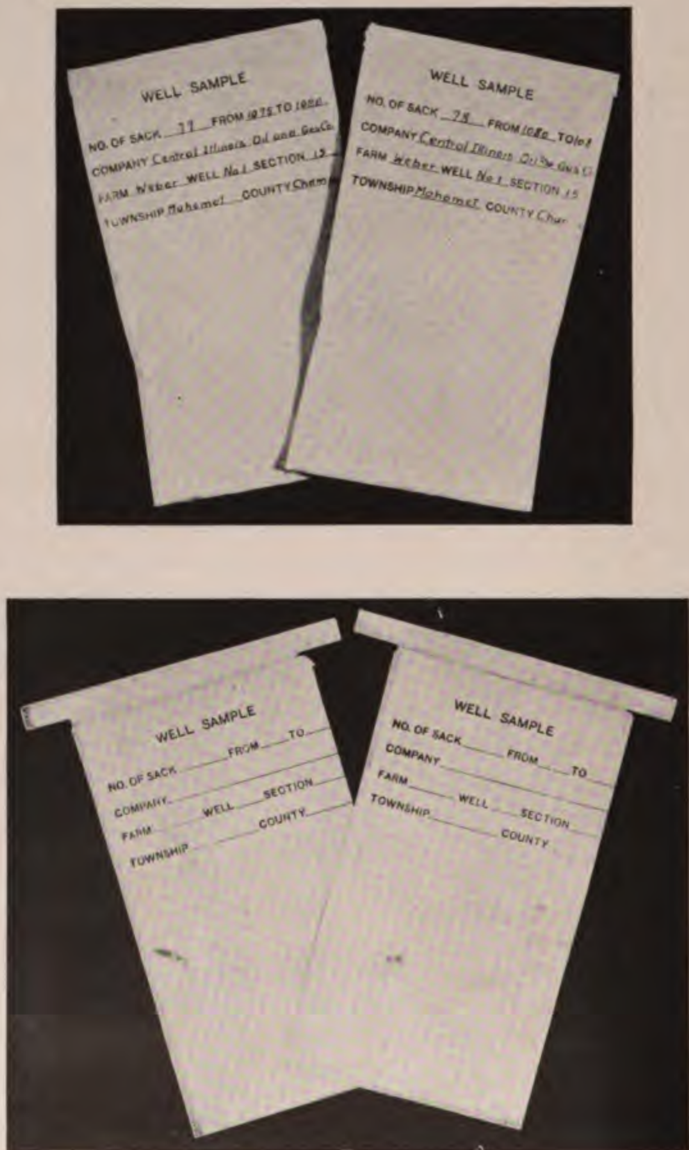

FIG. 2.—Well-sample sacks furnished by the State Geological Survey.

STRATIGRAPHY

PENNSYLVANIAN SERIES ("COAL MEASURES")

GENERAL DESCRIPTION

The main economic interest attached to the Pennsylvanian rocks in Illinois centers in the occurrence in these formations of all the workable coal beds known in the State. The series is underlain by the Mississippian strata, which are barren of coal, and is overlain only by the unconsolidated clays, sands, and gravels which constitute the glacial drift. Without this veneer, the coal-bearing beds would form the surface material for the entire area considered in this report with the exception of the western parts of Monroe and Randolph counties.

The Pennsylvanian consists of a series of shales and sandstones, and minor amounts of limestone, clay, and coal. The series thickens gradually toward the southeast part of the State, where it attains a thickness of 2000 feet.

The shales which compose the largest part of the section, range from the soft variety through all gradations of sandy shale to sandstone on the one hand, and by way of the limy shales to limestones on the other. The soft material is known as "soapstone" by the miner; whereas the harder forms which have well-developed bedding planes are called "slate", especially if the color is dark or black because of its high content of carbonaceous matter. Some of the shales contain a considerable amount of lime distributed irregularly, and this mixture is known to the driller as "lime shell", or simply "shell". In the black shales overlying the coals in many places the limy material was deposited or later collected in irregular masses between layers of the shale. In some mines these masses protrude through the roof and are commonly known as "niggerheads".

The sandstones are prominent in the lower part of the "Coal Measures". Near St. Louis these beds are less than 20 feet in thickness; whereas to the east near Carlyle, they reach 160 feet. Southward they thicken to 300 feet at Denny in Perry County; and still further south in Johnson County the sandstones, including lenses of shale, attain an aggregate thickness of more than 700 feet. A few beds of sandstone occur in the upper part of the "Coal Measures", but they are more or less lenticular and can not be traced over large areas. The section is variable, and a thick bed of sandstone recorded in one drill hole may be absent in another perhaps a mile distant.

The limestones, although constituting but a small part of the "Coal Measures", are nevertheless stratigraphically important, since many beds are more persistent than the coal beds themselves. Three horizons especially have been identified and traced over a large part

of the area considered in this report. One of these is in most places found within 30 feet above coal No. 6 and, in many areas, is separated from the coal by only a few feet of shale. In other places it rests on the coal itself and is called by the miner "rock top." In the interval from 200 to 325 feet above coal No. 6 two persistent limestones are present in many places. The lower is known as the Carlinville; and the upper, or Shoal Creek, about 100 feet higher is probably the bed that Udden has correlated with the Carlinville. Recent work by Wallace Lee of the U. S. Geological Survey seems to prove that the Carlinville and Shoal Creek limestones, heretofore regarded as the same bed, are really distinct horizons. In many logs it is impossible to determine which of these limestones is present, if only one of them is recorded by the driller.

A fourth limestone lies about 200 to 250 feet above the Carlinville and is found in the eastern part of District VII. It probably is identical with the limestone at New Haven, Gallatin County, doubtfully correlated with the Carthage limestone of old Kentucky reports.

Fire clays are normally associated with the coal beds, and in a carefully kept log may serve to identify the horizon of a coal, although the bed itself has been removed by erosion. These underclays in connection with the limestones mentioned above afford good key horizons for the correlation of the coals.

STRATIGRAPHIC DIVISIONS

For convenience of study, the coal-bearing beds of Illinois have been separated by geologists into the following divisions which are numbered in the order of age and deposition:

3. McLeansboro
2. Carbondale
1. Pottsville

POTTSVILLE FORMATION

The Pottsville formation is a series of sandstones, shales, and thin coals, comprising the base of the "Coal Measures". The name is applied to the beds below coal No. 2 and above the Mississippian sediments. The Pottsville beds were deposited upon an old land surface which had been exposed to erosion, and are consequently variable in thickness and in composition.

Sandstone is the predominating constituent of this formation and ranges from fine-grained material to typical conglomerate. Its composition is so irregular, however, that no definite character can be assigned to it. The study of a large number of drill records shows that individual beds of sandstone or shale can be traced but a short

distance, that one grades into the other laterally, that in one place the entire formation is represented by sandstone, whereas in another the sandy beds are almost absent. The variable character is well illustrated in the Carlinville oil field where 30 or 40 feet of porous sandstone may be found in one well, but within a few hundred feet may be absent or may be so closely cemented that it cannot act as a reservoir for oil.

A few thin coals lie within the Pottsville, but they have been explored only locally and are more or less lenticular; consequently their correlation presents great difficulties. T. E. Savage[3] and E. W. Shaw mention a persistent, 10-inch coal 40 to 70 feet below the Murphysboro (No. 2) coal. At Taylorville, Christian County, a coal 2 feet 5 inches thick lies 32 feet below No. 2 and is probably to be correlated with a similar bed reported in holes near Springfield. At the latter place several logs show a thin coal 130 to 150 feet below No. 2. This probably corresponds to coal No. 1 as described by A. H. Worthen, a former state geologist of Illinois.

The thickness of the Pottsville is variable. It averages 160 feet at Carlyle and attains a thickness of 250 feet in parts of Sangamon, Montgomery, Bond, and Fayette counties. It ranges from 20 feet in some places along the western part of St. Clair County to as much as 500 feet in Jackson County, and 700 feet in southern Gallatin County, where it forms conspicuous bluffs along the Ohio and further west in the valley of Eagle Creek.

In most drill records the base of the Pottsville can be placed at the first limestone after the drill has passed through all the main coal beds and has been working for some distance in a series composed mostly of sandstones and conglomerates. The top of the formation is difficult to identify where coal No. 2 is absent; throughout most of the district it averages 250 feet below coal No. 6.

The general characteristics of the Pottsville may be seen in the general section (Pl. II).

David White[4] has studied the fossil plants found in the formation, and regards the Illinois beds as corresponding in age to the beds of the same name in Pennsylvania.

CARBONDALE FORMATION

GENERAL DESCRIPTION

The Carbondale formation, which is typically exposed near Carbondale, Jackson County, includes all the beds from the base of coal No. 2 to the top of coal No. 6. Shales are predominant in this for-

[3]Savage, T. E., and Shaw, E. W., U. S. Geol. Survey Geol. Atlas, Murphysboro-Herrin folio (No. 185), 1912.

[4]White, David, Paleontological work in Illinois in 1908; Ill. Geol. Survey, Bull. 14, p. 293, 1910.

mation, and only irregular sandstones and minor amounts of limestone are present. The Carbondale includes all of the productive coal beds in Illinois, except the Rock Island (No. 1), Danville (No. 7), and three beds below No. 2 mined locally in Gallatin County. This series of beds, ranging from 250 to about 300 feet in the district, has a more uniform thickness than the Pottsville. Its total thickness is practically the same at Springfield, at Carbondale, and in the southeastern part of the State, although the individual beds composing the formation are more or less lenticular.

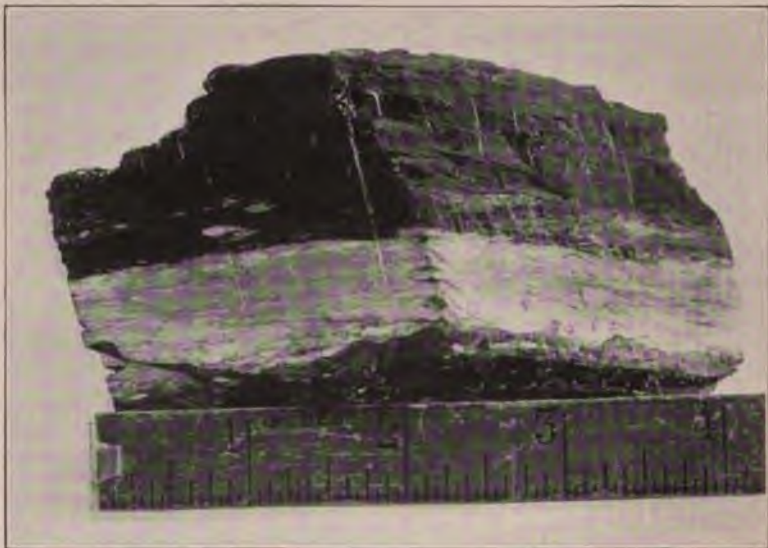

FIG. 3.—Photograph of "blue band," a characteristic feature in the lower part of coal No. 6.

COAL BEDS

In the earlier geological reports, the Illinois coal beds were designated by number beginning with the first one deposited. It was soon learned, however, that many of the coals are lenticular and could be traced but a short distance. Furthermore, numbers applied independently in different counties did not always agree. Since that time, only the beds that are present over a large area, or possess characteristic features for correlation, are regarded in nomenclature. The United States Geological Survey, in order to avoid the confusion of more or less meaningless numbers, has adopted place names and now designates the coals by such terms as *Belleville* or *Herrin* for the thick "blue-band" bed (No. 6), and *Springfield* or *Harrisburg* for the bed (No. 5) mined in the vicinities of those cities. Other names include *Rock*

Island (No. 1); *La Salle, Colchester*, or *Murphysboro* coal (No. 2); *Danville* coal (No. 7); *Grape Creek* coal (No. 6?).

The objection may be raised that in the commercial world, place names naturally come to carry a quality significance. Again, although the "third vein" at La Salle was probably deposited contemporaneously with coal No. 2 mined at Murphysboro, considerable confusion results in the designation of the bed by a single place name at so widely separated localities. It has been regarded advantageous by the State Geological Survey, to continue the use of numbers as synonymous with place names. The principal coal mined in the area of District VII will be called the Belleville coal or coal No. 6. It is locally called the "blue-band" coal on account of the band (fig. 3) which is commonly present not more than two feet above the bottom of the coal. The same bed is mined in Franklin and Williamson counties, but it was formerly designated as coal No. 7 in that region.

Although the Carbondale formation covers a large part of the State, no single coal bed is coextensive with the formation. Northward from an east-west line a few miles south of Springfield coal No. 6 becomes too thin for commercial recovery. At this place coal No. 5 develops to a thickness of 6 feet and is mined throughout the Springfield-Peoria district.

Coal No. 2 is probably the next in importance, although it is not present over the entire district. It commonly lies about 250 feet below No. 6 and is separated into two benches by a layer of shale or sandstone which varies in thickness from a fraction of an inch to 20 or 30 feet. The beds between coals No. 2 and No. 6 are irregular. A few of these are shown in the record given below.

Carbondale formation in the vicinity of Taylorville, Christian County

Byrd and Taylor Hole No. 8. Location—SE.¼ NE.¼ sec. 35, T. 13N., R. 1W.

(See Fig. 10)

Description of Strata		Thickness Ft.	In.	Depth Ft.	In.
Coal	No. 6	3	2	3	2
"Blue band"	No. 6	.	1	3	3
Coal	No. 6	2	3	5	6
Fire clay		1	10	7	4
Shale, gray		7	4	14	8
Shale, black		2	.	16	8
Shale, limy		5	6	22	2
Bone coal		.	3	22	5
Shale, dark		..	3	22	8
Shale, dark blue		1	4	24	0
Limestone		1	8	25	8
Limestone, sandy		4	6	30	2

Description of Strata		Thickness Ft.	In.	Depth Ft.	In.
Shale, gray		3	..	33	2
Limestone, shaly		8	6	41	8
Shale, sandy		15	..	56	8
Shale, blue, tough		27	..	83	8
Limestone		3	..	86	8
Shale, black		6	8	93	4
Coal		..	6	93	10
Clay		1	..	94	10
Limestone		..	6	95	4
Shale, soft		2	2	97	6
Shale, gray		1	..	98	6
Sandstone		1	2	99	8
Shale, sandy		18	..	117	8
Shale, blue		4	..	121	8
Coal		2	..	123	8
Shale, sandy		9	..	132	8
Shale, tough, blue		25	..	157	8
Shale, black		1	6	159	2
Coal		2	2	161	4
Clay		..	4	161	8
Shale, gray		6	8	168	4
Shale, dark		2	2	170	6
Coal		..	1	170	7
Shale, blue		..	7	171	2
Coal		2	10	174	0
Shale, gray		5	7	179	7
Sandstone		4	..	183	7
Shale, sandy		7	..	190	7
Shale, blue with brown bands		16	3	206	10
Coal		1	1	207	11
Clay		8	..	215	11
Shale, gray		24	..	239	11
Shale, sandy		4	..	243	11
Sandstone		3	5	247	4
Shale		1	3	248	7
Coal		..	3	248	10
Shale		1	6	250	4
Bone coal		..	3	250	7
Coal	No. 2?	1	2	251	9
Shale, blue	No. 2?	1	10	253	7
Coal	No. 2?	..	5	254	0
Shale, dark		3	7	257	7
Shale, sandy		14	8	272	3
Coal	No. 2?	3	11	276	2
Shale, sandy	No. 2?	3	5	279	7
Sandstone	No. 2?	8	4	287	11
Coal	No. 2?	3	8	291	7

DISTRIBUTION OF THE CARBONDALE

The outcrop line of coal No. 6 as shown on the general map (Pl. I) marks the upper boundary of the Carbondale. Part of the formation is exposed at the surface in valleys along the south and west sides of the district, but in most places it is covered by glacial drift. East and north of the coal outcrop the Carbondale dips deeper and deeper beneath the surface and is overlain not only by the drift, but by the McLeansboro formation as well.

MCLEANSBORO FORMATION

GENERAL DESCRIPTION

The McLeansboro formation includes all of the "Coal Measures" rocks above coal No. 6. It takes its name from McLeansboro, Hamilton County, Illinois, where borings have penetrated it to a depth of one thousand feet. It underlies the entire region north and east of the outcrop line of coal No. 6 and in most places is covered by a variable thickness of glacial drift.

The formation consists of shale and a minor amount of sandstone, limestone, and coal. Although two of the coals above No. 6 are persistent, neither has been found sufficiently thick to be of commercial value; and they are significant only as correlation horizons. In its barrenness of productive coals, and in general age, the McLeansboro is similar to the Conemaugh formation of Pennsylvania.

DISTINCTIVE HORIZONS

General section.—The well-marked stratigraphic units of the McLeansboro in this region may be enumerated as follows:

7. New Haven limestone, 200 to 250 feet above Carlinville limestone.
6. Shoal Creek limestone, about 100 feet above the Carlinville.
5. Carlinville limestone, so called because of typical outcrops near town of this name in Macoupin County. Its position is from 200 feet to a little more than 300 feet above coal No. 6.
4. Coal No. 8 ranging in thickness from 8 inches where present to 2 feet and lying 150 to 180 feet above coal No. 6.
3. A bed of pink, red, or variegated shale, variable in thickness, seldom exceeding 15 feet, averaging from 35 to 50 feet above coal No. 6.
2. Coal No. 7, generally only a few inches thick, 25 to 40 feet above coal No. 6.
1. A hard limestone, averaging 7 feet in thickness overlying or slightly above coal No. 6.

The beds mentioned above are reasonably persistent and serve as correlation horizons on which considerable dependence may be placed. The intervening beds vary so greatly in character that they are of little use in the determination of geologic age.

1. *Limestone above coal No. 6.*—In most of the area under consideration coal No. 6 has a limestone "cap rock". In some places this is underlain by black slate a few feet in thickness, and in others by a gray shale known as "white top." In restricted areas the limestone is absent, as in Tps. 9 and 10 N., R. 6 W., Macoupin County, where 30 to 40 feet of shale overlie the coal and render roof conditions unsatisfactory. The roof limestone varies considerably in thickness. It is generally not less than 2 feet thick, but a large number of records show the average to be between 5 and 10 feet.

It is not to be understood that "rock top" is invariably good roof. Here and there it lacks uniform bedding and is so weakened by vertical fractures that great difficulty is experienced in supporting it. In one mine having a 7-foot limestone roof bad falls continue to be troublesome despite all reasonable efforts for their prevention, and it is not uncommon to see "roof falls" as much as 50 feet long and 30 feet high. Ordinarily, however, the limestone possesses much greater strength than any of the other roof materials except a thick hard sandstone. The latter type is exceptional in District VII.

2. *Coal No. 7.*—A bed of coal, commonly not more than 3 or 4 inches thick and locally absent, is in most places present 25 to 40 feet above coal No. 6. In the Springfield Quadrangle,[5] this coal averages only 2½ inches in thickness, and in places is represented only by a thin bed of black shale.

In Montgomery, Christian, Bond, and St. Clair counties, most of the careful records show this coal bed. Its thickness is ordinarily less than 1 foot, but here and there it is reported as thick as 2½ feet. Its roof is variable, commonly a dark shale overlain by a thin limestone, but no uniform succession prevails.

3. *Pink, red, or variegated shales.*—Considering that the thousands of records used in this study of Illinois coals were made by many different drillers, it is remarkable that the presence of a thin bed of colored shales has been so regularly reported within 50 feet above coal No. 6. Such shales exist over most of the area in which coal No. 6 is present. As a rule they lie a short distance above the horizon of coal No. 7. They are important only because they are easily distinguished from the bluish-gray shales so common in the "Coal Measures" and are restricted to the horizon mentioned. They are not so thick nor so brilliantly colored as are the Chester red beds of the Mississippian, which outcrop in southwestern Illinois and underlie the south half of the State.

4. *Coal No. 8.*—In a majority of the records from this district, a thin coal is reported from 150 to 180 feet above No. 6. This bed

[5]Shaw, E. W. and Savage, T. E., U. S. Geol. Survey Geol. Atlas, Tallula-Springfield *folio* (No. 188) p. 5, 1913.

is not of commercial importance, but its wide distribution makes it of some use in correlation. It is associated with shales above and below in most places, although a few records indicate thin limestones underlying the coal. Its position is approximately halfway between coal No. 6 and the Carlinville limestone.

5. *Carlinville limestone.*—The Carlinville limestone is one of the most widely distributed beds in the "Coal Measures" of Illinois. It has been traced from north of Carlinville, Macoupin County, southeast to the Indiana line in Gallatin County.

In the type localities this limestone is, according to Udden, "generally bluish gray, compact, close textured, and very hard, breaking into irregular, splintery pieces. On weathering it assumes a rusty color. It averages about seven feet in thickness. There are two features that are characteristic of this limestone, one a blotchy appearance and another its tendency to weather into seams two and one-half or three inches in thickness".[a]

In most places the limestone is covered by glacial drift and is seen only along its western border. Even here it outcrops only where streams have removed the surface covering. It dips toward the east and can be traced by a study of drill records.

In most of the district, the interval between this limestone and coal No. 6 averages from 275 to 325 feet. However, in the vicinity of Carlinville, Macoupin County, it decreases to 200 or 220 feet. At the Virden shaft, on the north side of the county, the interval measures 249 feet.

Some confusion has resulted in attempts to correlate the Carlinville limestone with certain beds in Kentucky and Indiana. Earlier reports have given the impression that the Carthage limestone of Kentucky, named by Owen, is equivalent to the Carlinville of Illinois, and the two terms have been used indiscriminately. Owen's section, quoted in Bulletin 17 of the Kentucky Geological Survey, places the Carthage limestone 440 feet above coal No. 11 (No. 6 of Illinois). Recent studies in Illinois, and private correspondence with Mr. L. C. Glenn, formerly of the Kentucky Geological Survey, indicated that the Carlinville corresponds to a limestone 250 to 300 feet above coal No. 11 (Illinois No. 6) well exposed at Madisonville, Kentucky.

6. *Shoal Creek limestone.*—In many of the drill records, three or four thin limestones are noted in the zone from 250 to 350 feet above coal No. 6 and in such a case, it is impossible to identify the Carlinville. Indeed, recent co-operative work by Wallace Lee, of the U. S. Geological Survey, in the typical area of the exposed Carlinville limestone, leaves small room for doubt that the Shoal Creek limestone correlated

[a]Udden, J. A., Shoal *Creek Limestone*: Ill. State Geol. Survey Bull. No. 8, p. 119, 1908.

by Udden with the Carlinville, is really a bed which lies about 100 feet above the latter. The following paragraphs, describing the Carlinville, Shoal Creek, and other limestones in the Gillespie and Mt. Olive quadrangles, were kindly furnished by Mr. Lee. A more detailed report will appear under his name in folios to be published by the State and Federal surveys in cooperation.

Two continuous limestone beds, and a thinner somewhat discontinuous but persistent limestone between, outcrop in the Gillespie and Mt. Olive quadrangles. The lowest, the Carlinville limestone, lies from 200 to 225 feet above the Herrin coal, but this interval fluctuates irregularly, and at the eastern margin of the field where the drill logs show the limestone to become thin and irregular the interval falls to 175 feet. The bed, where best developed, is six to seven feet thick and is tough, gray, dense, and homogeneous. At the head of Cahokia Creek, where all three limestones are exposed, the uppermost bed is about 75 feet above the Carlinville. Its base is from 275 to 325 feet above the Herrin coal, but toward the south the interval increases, being 350 feet at the Future mine at Breese. The limestone is from 12 to 25 feet thick, but lacks the homogeneity of the Carlinville. It consists of a series of more or less argillaceous limestone layers, but in certain localities either the top, bottom or middle of the bed is replaced by limey shale. The weathered face presents a ragged appearance due to fine conchoidal jointing and is in sharp contrast to the cleanly weathered and regularly jointed faces of Carlinville outcrops.

Examination of a series of drill holes extending south along Shoal Creek indicates that the upper limestone is probably to be correlated with the Shoal Creek limestone of the Breese area, though the distance above the Herrin coal is slightly greater. The Carlinville limestone, however, becomes thin and less regular to the south, but cannot be identified positively in the drill logs of the Breese area. The intermediate limestone, although exposed at a number of localities west of Gillespie, is not a continuous bed; it is usually only two to three feet thick. Its reported presence in drill logs in close association with a continuous black shale or thin coal bed is frequent enough to suggest that it occupies a definite position in the section, and that it may prove to be better developed in adjoining areas. Its position varies from 30 to 50 feet below the base of the Shoal Creek.

On the outcrop, the beds may be distinguished by a difference in physical appearance, but in drill records it is impossible to differentiate them positively. In most places a thin coal lies only a short distance below the Shoal Creek bed. Where careful record has been kept, it is often possible to make correct correlations by noting the position of this coal.

7. *New Haven limestone.*—About 200 to 250 feet above the Carlinville is a limestone which is encountered in nearly every drill hole that reaches coal No. 6 at a depth of 700 feet or more. The persistent nature of the bed is shown graphically in records from Moultrie, Shelby, Montgomery, and Fayette counties (fig. 4). Owing

to the eastward dip, the outcrop line of the limestone parallels that of the Carlinville at a distance of fifteen or twenty miles east of the latter.

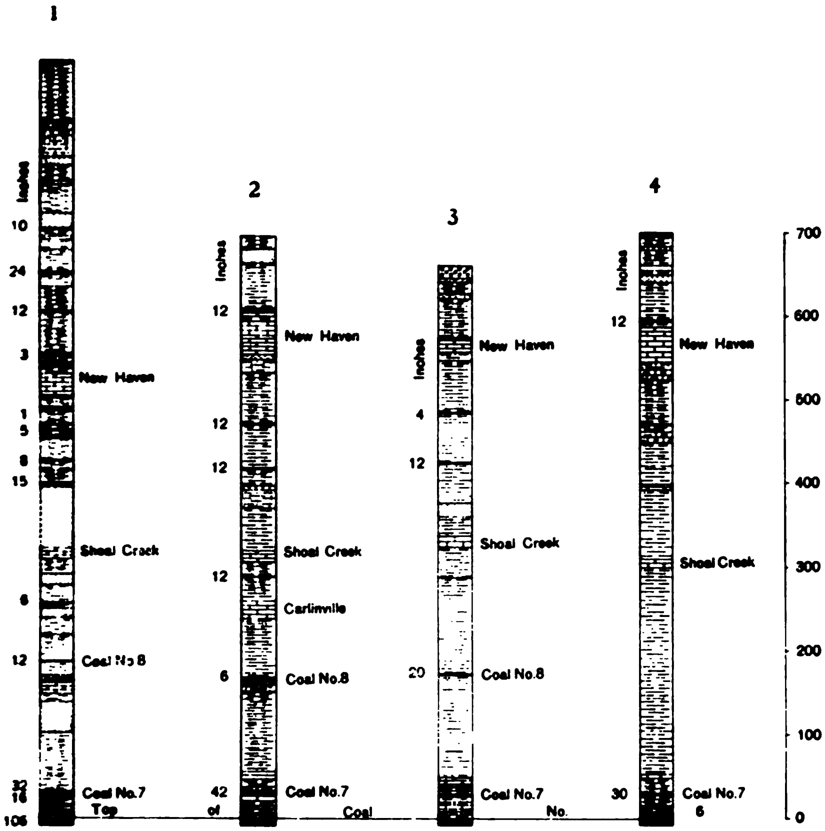

FIG. 4.—Sections showing persistent nature of limestones in the McLeansboro formation.

1. Lovington, Moultrie County.
2. Sec. 8, T. 10 N., R. 1 E., Shelby County.
3. NW.¼ NW.¼ sec. 8, T. 9 N., R. 1 W., Montgomery County.
4. Sec. 29, T. 9 N., R. 1 E., Fayette County.

In drill records this upper limestone appears to be a solid bed which in most of the logs is given a thickness of at least 25 feet. It may be traced on outcrop and in drill holes to New Haven, Gallatin County, where it shows in typical exposure, NE. ¼ sec. 20, T. 7 S., R. 10 E.

Older Kentucky reports[7] describe a limestone as lying 450 feet above a coal corresponding to No. 6, and to the limestone the name

[7]Geol. Survey Kentucky, vol. 3, 1857, p. 20.

Carthage is given. In recent years, however, L. C. Glenn in private correspondence suggests that in the early reports, too great a thickness was assigned to the interval between the coal and the limestone at Uniontown, Ky., and that in reality the interval is only about 200 to 275 feet.

At present it seems best not to attempt correlation of the Illinois limestone with that of Kentucky; but in order to designate the bed 450 to 500 feet above coal No. 6 in Illinois, it will be known in this report as the New Haven limestone.

The following log is typical of the eastern part of District 7:

Drill record typical of eastern part of District VII
Operator—H. H. Brown. Hole—W. H. McNichols.
Location—NW.¼ NW.¼ sec. 8, T. 9 N., R. 1 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Surface	14	..	14	..
Sand	3	..	17	..
"Softpan"	13	..	30	..
Sand	8	..	38	..
"Softpan"	48	..	86	..
Wash	4	..	90	..
Limestone (New Haven)	13	..	103	..
Sand and shale	10	..	113	..
Shale, gray	63	7	176	7
Coal	..	4	176	11
Clay	4	..	180	11
Clay shale	12	..	192	11
Shale, gray	40	1	233	..
"Slate," black	2	..	235	..
Coal	1	..	236	..
Clay	2	..	238	..
Clay, shale	20	..	258	..
Shale, brown	22	..	280	..
Sand rock	15	..	295	..
Shale, light	26	8	321	8
Limestone (Carlinville)	13	..	334	8
Sand shale	35	4	370	..
Sand shale, gray	7	..	377	..
Shale, dark	18	..	395	..
Slate, black	1	..	396	..
Shale, gray	5	..	401	..
Clay shale	24	..	425	..
Shale, brown	51	3	476	3
Shale, light	9	3	485	6
Coal (No. 8)	1	8	487	2
Clay, light	2	7	489	9
Shale, blue	9	3	499	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Shale, dark	85	6	584	6
Shale, blue	5	6	590	..
Shale, light	2	..	592	..
Shale, blue	17	..	609	..
Shale, various colors	4	..	613	..
Shale, dark	3	..	616	..
Limestone	5	..	621	..
Shale, blue	1	..	622	..
Shale, dark	3	..	625	..
"Slate," black	4	..	629	..
Shale, dark	2	..	631	..
Coal (No. 7)	1	10	632	10
Shale, dark	3	2	636	..
Lime shale	6	6	642	6
Limestone	5	6	648	..
Lime shale	4	5	652	5
Limestone	..	6	652	11
"Slate," black	5	7	658	6
Coal (No. 6)	7	6	666	..
Fire clay				

STRUCTURE

Explanation of Geologic Structure

DEFINITION

The term *geologic structure* is used to denote the attitude or "lay" of rock beds. It is common belief that in Illinois all of the formations are horizontal. This belief is due to the gentleness of dips over most of the State, and also to the surficial drift cover, which obscures the underlying formations. It is only upon studying large areas in detail that the real structure may be determined.

METHOD OF DETERMINING STRUCTURE

The large map (Pl. I) was prepared for the purpose of showing the position of the beds underlying the district. In favorable regions a map would be prepared from data collected at the outcrops of the different formations, but as has been mentioned, over most of the region all the beds are covered by unconsolidated sands, clays, and gravels, known as glacial drift. In such an area, it is necessary to collect and study all available data from drill records. On Plate I drill holes, the logs of which are filed in the office of the State Geological Survey, are indicated by appropriate symbols. These records have been obtained from many sources. For the most part they represent test holes for coal and *petroleum*. Almost without exception the opera-

tors have furnished their logs for purposes of study. The Survey is requested to hold a large number of records confidential, and for this reason the thickness of the coals is not shown on the map. All of the information has been available for study in the office, and it is believed that the correlations from one hole to another and from one county to another are correct.

STRUCTURE CONTOURS

Prominent, irregularly curved, red lines bearing conspicuous numbers ranging from 450 to -400 extend in a general north-south direction across the map. These contour lines show the position of coal No. 6 above sea level. Since in this area the beds above and below No. 6 are essentially parallel to it, the general geologic structure is indicated by the lines representing the top of this coal bed. Coal No. 6 was selected for contouring because of the ease of its identification over most of the area.

Figure 5 has been prepared to illustrate in a concrete manner, the significance of contour lines. It is merely a reduced copy of Plate I with shading to accentuate the folds indicated by the contours. A clear understanding of figure 5 will enable the reader to use the large map intelligently.

The reader is requested to imagine all the rocks removed to the top of coal No. 6. In other words, suppose this coal bed to be the surface of the ground. Again, imagine the area to be flooded by an arm of the ocean, the water standing at present sea level. The shore line would be represented by the contour marked 0 on the map. If the level of the water were raised by 50-foot intervals, the successive shore lines would be indicated by the corresponding contours. The upward folds, or anticlines, would extend out into the sea as long arms of land; whereas the downward folds or synclines would be covered by bays and lagoons. In places, as at Centralia, Marion County, and others which are evident, isolated portions of the surface would rise above the level of the sea as islands.

On Plate I the contour interval is 50 feet. The elevation of the coal above sea level was determined in each case by subtracting from the surface elevation, the figure representing the depth to the top of coal No. 6 as given in the drill record or shaft record.

ACCURACY OF STRUCTURE CONTOURS

The accuracy of structure contours depends directly on (1) the number and distribution of the drill holes whose records are used, and (2) the correctness of the surface elevations.

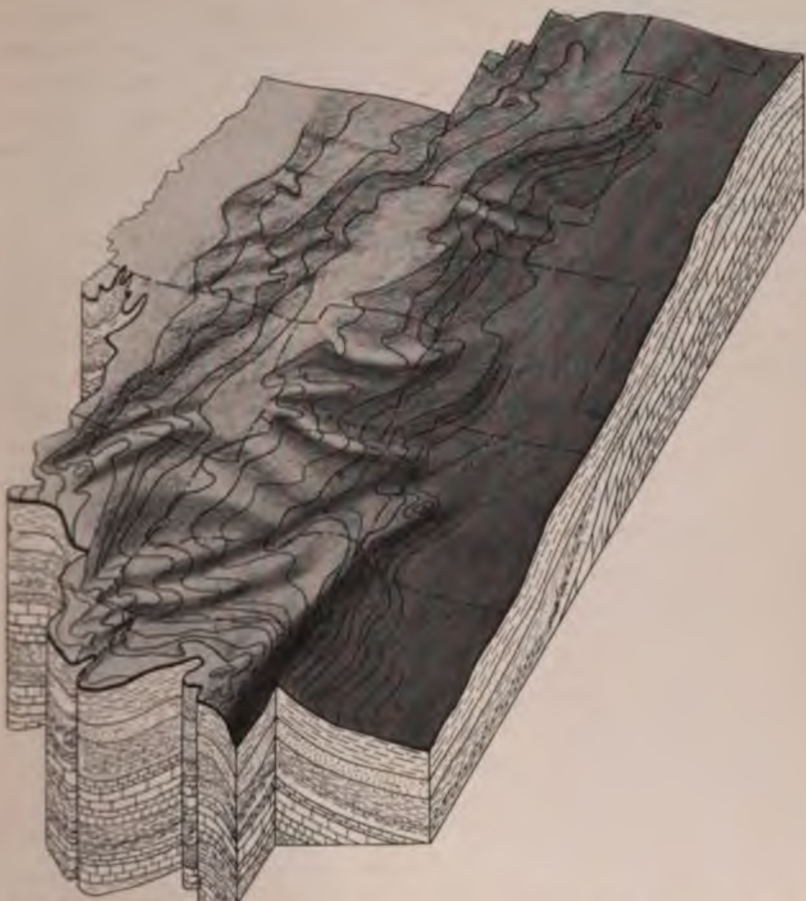

FIG. 5.—Surface of coal No. 6 as it would appear if all the overlying material were removed. The diagram shows the significance of the structural contour line. (Shading by Geo. H. Renshawe.)

(1) In a region where the drill holes are numerous and evenly distributed, the position of the contours is closely determined. It is also possible to use a small contour interval and thereby introduce great detail. The data available for District VII would not permit the use of an interval less than 50 feet. In areas furnishing meagre information, doubt is expressed by the use of broken contours.

(2) Surface elevations have been determined by various methods. In the East St. Louis, Belleville, Breese, Carlyle, Okawville, and New Athens quadrangles, most of the elevations were determined with a hand level by E. W. Shaw of the U. S. Geological Survey and J. A. Udden of the Illinois Geological Survey.

In the collection of drill records an attempt is always made to secure the correct elevation of the top of the holes. This is usually done by reference to an established bench mark or to a railroad elevation which has been adjusted to sea level as a datum plane. A few operators have been able to furnish accurate levels to all of the holes drilled under their direction. For scattered wells, reference has been made to the Rolfe topographic map of Illinois made in 1892-3. These elevations have been adjusted where necessary. The writer is indebted to Messrs. Fohs and Gardner of Tulsa, Okla., for instrumental levels in parts of Montgomery and Bond counties. During the summer of 1913 stadia levels were run by J. E. McDonald of the Cooperative Mining Investigation to holes in Christian, Montgomery, Bond, Fayette, Clinton, and Jefferson counties, for which elevations were uncertain.

PRACTICAL USE OF MAP

The general base map has been compiled from the best available data. Each smallest square represents a section of approximately 640 acres. On this base is shown the areal distribution of coal No. 6, its approximate depth at any given point, and its position with reference to sea level. The locations of drill holes or outcrops from which the data have been secured are also indicated. For points located between contour lines, intermediate elevations may be assigned to the top of coal No. 6, for example: the elevation of the coal at a point halfway between the 250-foot and the 300-foot contours, would be 275 feet. Figures obtained in this way are approximately correct and are sufficient for all practical purposes.

Certain black figures on the map show surface elevations. In order to determine the depth to coal No. 6, it is necessary only to add to, or substract from, the surface elevation the figure representing the elevation of the coal (obtained from the nearest contour line). For example: Beckemeyer, Clinton County, is about halfway between contours 0 and 50; the top of coal No. 6 is therefore 25 feet above sea level. The surface elevation at Beckemeyer is 452, and by subtracting as indicated above, the depth to coal is found to be approximately 427 feet. Where the coal is below sea level, the altitude must be added to the surface elevation to secure the depth to coal.

The absence of contours on the east part of the map does not signify the absence of coal, but merely the lack of sufficient information regarding it. Few holes have been drilled in the deeper part of the basin, because in this territory drilling and mining will be more costly and will be undertaken only when the shallower coal is no longer available.

where the conditions are favorable.

RELATION OF OIL AND GAS ACCUMULATION TO GEOLOGIC STRUCTURE

In Illinois the accumulation of oil and gas appears to be controlled by the anticlines or arches in the beds. For the most part, the rocks

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Structure of District VII

RELATION TO GENERAL STRUCTURE OF ILLINOIS

The "Coal Measures" of Illinois occupy a spoon-shaped basin, its deepest part being in Hamilton, Wayne, and White counties. The long axis of the "spoon" passes near Olney in Richland County and Lovington in Moultrie County. The position of the basin may be seen in Plate III. The district under consideration forms the southwestern part of the "spoon", and the general dip is east or north towards the main axis of the basin. The dip is not regular but varies in direction and degree as shown in Plate III. Coal No. 6, the main bed in the region, outcrops in the Mississippi River bluffs at an elevation of about 470 feet above sea level. An average eastward dip of about 14 feet per mile carries it 300 feet below sea level 5 miles east of Centralia, Marion County.

DUQUOIN ANTICLINE

The main modification of the structure is the Duquoin anticline named from the town in Perry County near which the fold is well developed. West of town the beds lie almost flat with slight dip north and northwest; whereas for some distance east of town, the eastward dip is 300 feet per mile. Properly speaking, this one-sided fold is a monocline. The top or axis extends N. 10° E. through Duquoin to Sandoval, Marion County, north of which place it appears to lose its identity.

RELATION BETWEEN COAL NO. 6 AND OIL SANDS

A detailed explanation of oil and gas accumulation would be out of place in this report but it is regarded advisable to mention the use of the map in determining the geological structure of beds other than the coals. In a general way the successive beds were deposited parallel to one another. This parallelism is not absolute, but for practical purposes in Illinois it may be assumed. After deposition, pressure was exerted on the strata in certain horizontal directions and all of the beds were affected similarly. If the position of one bed or formation is shown, those above and below may be regarded as having parallel structure. Since the structure of coal No. 6 as shown on the map represents almost equally well the structure of any oil or gas horizons, the map may be of use in selecting locations for drilling where the conditions are favorable.

RELATION OF OIL AND GAS ACCUMULATION TO GEOLOGIC STRUCTURE

In Illinois the accumulation of oil and gas appears to be controlled by the anticlines or arches in the beds. For the most part, the rocks

are saturated with salt water which may be original water from the sea in which the beds were deposited, or it may have been fresh water that has dissolved mineral salts while percolating through the underground rocks. It is supposed that originally the particles of oil resulted from decomposition of vegetable or animal matter, or both, which lay buried at the bottom of a sea under a variable amount of sands and clays that now cover the oil-bearing beds.

In Illinois after the deposition of the oil-bearing rocks and those overlying them, and at a time probably corresponding to the uplift of the Ozark Mountains, adjustment to pressure resulted in more or less bending of the formations into anticlines and synclines. Gravity immediately had its effect in causing the general downward movement of the water and oil where no greater opposing forces operated. In some cases, the water and occluded oil must have moved up the dip in response to a higher head of water with which it was connected.

Not only did the water move up or down according to conditions, but the oil tended to rise to the top of the water owing to its lower specific gravity. Wherever an upward fold existed in the beds, the oil and gas rose to the top of such a fold and was trapped or held there under pressure of the water below. Naturally the gas, being lighter than oil, rises above the latter and is found in the highest part of the fold. In prospecting for oil, therefore, it is best not to drill in the topmost part of a dome or anticline, but slightly down dip from the axis of the fold, since the top may contain only gas as stated above.

Some of the folds in Illinois are arches whose axes extend many miles; others are shaped like an inverted saucer in which case they are called domes. Between the two forms all gradations exist such as elongated domes, anticlines whose axes are not horizontal, and terraces of different shapes.

In a general way, the structural features described below indicate the areas in which conditions are favorable for oil and gas accumulation. A report[8] by Raymond S. Blatchley has covered the relationship of the areas mentioned below to petroleum, in greater detail than is desirable in the present report.

The areas regarded favorable for oil and gas in the southern part of the district have been described by R. S. Blatchley[9] and E. W. Shaw.[10]

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[8]Blatchley, Raymond S., Oil resources of Bond, Macoupin, and Montgomery counties: Ill. Geol. Survey, Bull. 28, 1914.

[9]Blatchley, Raymond S., Oil resources of Illinois: Ill. Geol. Survey, Bull. 16, 1910.

[10]Shaw, E. W., Carlyle oil field and surrounding territory: Ill. Geol. Survey, Extract Bull. 20, 1912.

STRUCTURAL FEATURES

LIST OF FEATURES

Of these structural features those designated by an asterisk are now described for the first time:

1. Ohlman anticline*
2. Hillsboro flat*
3. Sorento dome*
4. Ayers anticline*
5. Carlinville dome
6. Staunton dome*
7. Pocahontas anticline*
8. Carlyle anticline
9. Irishtown anticline
10. Bartelso dome
11. Hoffman dome
12. Nashville anticline
13. Venedy dome
14. Darmstadt anticline
15. White Oak anticline
16. O'Fallon anticline

1. OHLMAN ANTICLINE

The Ohlman anticline is a low arch whose axis extends in a north west-southeast direction through the northeastern part of T. 10 N., R. 2 W. So far as known, the beds are highest near the NE. corner sec. 3, T. 10 N., R. 2 W., where the coal lies 76 feet above sea level. From this point, the beds dip in all directions except northwest, in which direction there is probably a gradual rise although details are not known. At the crest of the anticline the coal is about 35 feet higher than in wells located in sec. 10, T. 10 N., R. 2 W., and sec. 26, T. 11 N., R. 2 W. Southeast from the crest, the coal drops to a few feet above sea level in sec. 12, T. 10 N., R. 2 W., and lies almost flat over several square miles south and southwest of Ohlman as shown by the position of the 0 contour. The anticline is therefore a small structural feature.

2. HILLSBORO FLAT

For several miles in all directions from Hillsboro the coal lies practically flat. On the map the area is shown between the 150 and 200 contours. The Hillsboro flat covers parts of Tps. 7, 8, and 9 N., Rs. 3, 4, and 5 W.

It extends southward from the Christian County line to Walshville and from 4 miles east of Hillsboro to 2 miles east of Litchfield. The total area covered is about 200 square miles. Near the eastern

side of the flat in the vicinity of Hillsboro a narrow elongate dome rises 15 to 20 feet above the surrounding structure, but not high enough to be shown by contours on the map. The axis of the narrow fold extends through Hillsboro and to a point about 3 miles southwest of that city. The fold itself averages 1 mile in width. Over the entire Hillsboro flat, coal No. 6 lies almost flat at about 175 feet above sea level.

3. SORENTO DOME

Rising above the Hillsboro flat is the Sorento dome. The area is shown on the map within the oval-shaped contour marked 200 which includes parts of southwestern Montgomery and northwestern Bond counties. The highest part of the dome is in the southwestern portion of T. 7 N., R. 5 W., where the coal reaches an altitude of 250 feet above sea level. This structural feature belongs to the type known as an elongated dome. Its long axis extends northeast-southwest, the length of the dome being almost three times its width. In the area surrounding the dome the elevation of coal No. 6 varies from 150 to 200 feet above sea level.

4. AYERS ANTICLINE

Eastward from the south end of the Sorento dome the beds are arched into an anticline named from the town of Ayers. The axis of the fold extends east across the north tier of townships in Bond County. The anticline is flanked on the south by a decided depression near Smithboro and Greenville, where the coal lies from 60 to 100 feet above sea level. Near Ayers the coal reaches an elevation of 165 feet. From this district it dips northward, but data are rather meagre and the exact shape of the north side of the anticline is unknown. Toward the east it seems to lose its identity in Fayette County.

5. CARLINVILLE DOME

The Carlinville dome was described in Extracts from Bulletin 20. The large contour interval of the present map fails to show the real nature of the fold, which is a dome somewhat elongated in an east-west direction. The coal in the highest part of the fold lies 379 feet above sea level. The axis extends east and west in secs. 7 and 8, T. 9 N., R. 7 W., Macoupin County. Gas under a pressure of about 135 pounds was found in the top of the dome. Three or four wells have furnished the gas supply for Carlinville for a number of years, but the pressure had fallen to 35 pounds in 1911, and there is little prospect of any marked increase. At present 10 wells are producing about 40 barrels of oil per day from the sides of the dome. The

sands lie in the base of the "Coal Measures" next overlying the St. Louis limestone or "Big Lime" of the driller, the Chester beds being absent.

6. STAUNTON DOME

Recent levels for which the Survey is indebted to the Chicago and Northwestern R. R. indicate a doming of the beds three miles northwest of Staunton, Macoupin County. The highest part of the dome so far as known is in secs. 7 and 18, T. 7 N., R. 6 W., and secs. 13, 14, and 15, T. 7 N., R. 7 W.

7. POCAHONTAS ANTICLINE

The shape of the Pocahontas anticline is doubtful. Drill holes located in secs. 28 and 32, T. 5 N., R. 4 W., indicate that the coal is higher than it is south and north of this locality. In sec. 32, T. 5 N., R. 4 W. its elevation is 179 feet above sea level; whereas in sec. 15, three miles north, the top of the coal lies at 76, a condition which shows a dip of more than 30 feet per mile. To the south a slight depression exists in the coal in the vicinity of Pocahontas, as shown by a drill hole in sec. 8, T. 4 N., R. 4 W., in which the coal is 125 feet above the sea. This syncline appears to be a minor feature, however, since in the southeast part of the township the coal has the same elevation as in the Pocahontas anticline, in what appears to be the crest of the Irishtown arch, noted by E. W. Shaw. The Pocahontas anticline appears to lose its identity east of Shoal Creek.

The descriptions of the structural features listed below are quoted from E. W. Shaw.[11]

8. CARLYLE ANTICLINE

The Carlyle anticline or elongated dome is a very low arch, the central line of which extends from the Baltimore and Ohio Railroad about midway between Carlyle and Beckemeyer a little east of north for three or four miles. The highest part is near the middle, where the rocks are only a little higher than they are to the north. They are, however, higher than the same beds to the east, south, or west and this dip of the rocks in three directions away from the center of the dome seems to be the most important fact in the development of an oil pool.

At Carlyle and Beckemeyer and for some distance south and southwest the Herrin coal (No. 6) is 15 or 20 feet above the sea; to the east and southeast it dips to 50 or 60 feet below the sea level in the vicinity of Huey. Northwest from Carlyle the road rises toward the center of the field where it is 50 to 60 feet above the sea. West from Carlyle the coal dips gently again almost to sea level, but northwest it does not sink so low and it is not known to lie within 25 feet of sea level anywhere northwest of the pool. To the north and

[11]Shaw, E. W., The Carlyle oil field and surrounding territory: Extracts from Bull. 20 Ill. Geol. Survey, p. 20-25, 1912

northeast, however, it descends to an altitude of 15 to 20 feet above sea in a distance of 2 or 3 miles.

It may seem remarkable but it is a fact that the shape of the Carlyle oil pool does not correspond to the shape of the anticline as it is developed in the coal-bearing rock. The place where the coal is highest is well to the northwest of the center of the pool; but when the variable thickness of the strata is remembered, the surprising fact is that the outline of the dome in the coal-bearing rocks is so near the outline of the pool. Layers of sandstone in particular vary greatly in thickness, and it is surprising that when many such layers are piled one on top of another the uppermost is so nearly parallel to the lowest.

9. IRISHTOWN ANTICLINE OR STRUCTURAL TERRACE

In the central part of Irishtown township, 5 to 7 miles north and 2 to 3 miles east of Carlyle, the coal lies 50 to 70 feet above sea. The details of the structure in this vicinity are not known for there are few outcrops and artificial excavations which show recognizable strata, but the coal is certainly higher than it is midway between this district and the Carlyle anticline, and it is considerably higher than the same bed a few miles to the east. Apparently there is a low anticline here which plunges and fades out to the east. Two wells drilled here in the fall of 1911 obtained no showing of oil. The highest known point in the coal in Irishtown township is at the Ohio Oil Company's well on the Michel farm near the middle of section 17, but as the sands and the coal are not absolutely parallel to the highest point in the sands may be a mile or two away from the middle of section 17.

Recent drilling in sec. 26, T. 4 N., R. 4 W. shows coal No. 6 to be 163 feet above sea level and it is believed that this area is the westward continuation of the Irishtown anticline as described by Mr. Shaw, although conclusive data are lacking.

10. BARTELSO DOME

There is fairly good evidence of a low dome one to two and a half miles north and a little east of Bartelso. Five wells have been sunk in the vicinity of Bartelso and both the coal and the sands seem to be rising toward a point a short distance to the northeast of the town and indications of oil have been found. Four to seven miles north and northeast of Bartelso the strata are low and probably barren of oil; but between this place and the town there is possibility of a pool.

11. HOFFMAN DOME OR ANTICLINE

At Hoffman, about 11 miles east of Bartelso, the strata are high, the coal according to a diamond drill record being 37 feet above sea, whereas a very few miles to the northwest, north, and east, it is below sea level. It may dip to the south also, and if so, the structural feature is a dome; otherwise it is an anticline, which plunges to the northeast. In either case it is well worth a test for oil.

The structure between Hoffman and Bartelso is not known. Most likely there is a shallow syncline, but there is a possibility of a small arch.

12. NASHVILLE ANTICLINE

At Nashville the strata have a noticeable rise to the west, but a mile north of Addieville they seem to be 50 feet lower. From what is known of the "lay" of the rocks there appears to be a broad but fairly steep-sided anticline plunging slightly to the northeast but perhaps extending without a break northeast to the Hoffman dome. There is some indication that the anticline is double crested, one crest being southeast and one northwest of Nashville. To the southwest the anticline becomes less pronounced. At Oakdale it appears to be broad and low, though farther to the southwest toward the Sparta field it may become higher and steeper. It may be however that this uplift is not an anticline but a dome. If so, its position is 2 to 4 miles west of Nashville.

13. VENEDY DOME

In a deep well near the old town of Venedy about 6 miles southwest of Okawville, the coal is reported to lie at a depth of 212 feet, or 250 feet above sea. This is higher than it lies in surrounding territory, but the details of this dome or anticline are not yet known.

14. DARMSTADT ANTICLINE

The Darmstadt anticline has a northeast-southwest trend, and is somewhat irregular. It probably extends northeast to the Venedy uplift, beyond which it appears to be double crested ,one crest running nearly north to New Memphis, and the other northeast to Okawville. The anticline seems to be highest near Darmstadt, where the coal bed reaches an elevation of 298 feet above sea, whereas it is 50 to 75 feet lower to the west, north, and east. It may, or may not, be lower to the northeast, and there is a possibility that it is lower to the south and is a dome. It is at least a well-marked uplift, flanked on the northwest and southeast by synclines, and is one of the most worthy places in the region for a test well.

15. WHITE OAK ANTICLINE

A low anticline plunging gently to the northeast extends in a southwest-northeast direction through White Oak, where it is unsymmetrical, the southeast limb being rather steep and about 40 feet high, and the northwest being less than 10 feet high. It thus has somewhat the form of a terrace facing southeast, but the distinct slope to the northwest makes it an anticline. To the southwest its limits are not known. It may extend as far as Baldwin. To the northeast it appears to broaden and to extend nearly to Lively Grove. The highest known point is 6 or 7 miles east and 2 miles north of Marissa, where the coal is reported in a test hole to be 295 feet above sea. This is higher than the coal lies either to the northwest, northeast, or southeast. But, unfortunately, there is very little information on the position of the strata in this district, and hence the structure is somewhat doubtful. There may be a dome just northwest of the middle of Lively Grove township, and the anticline may be high or low, steep sided or gently sloping. But in any case, the anticline should be tested before adjacent territory One test has already been sunk near White Oak and no oil was found. Another test on this anticline might be very well located 5 or 6 miles northeast of White Oak.

16. O'FALLON ANTICLINE

The O'Fallon anticline was pointed out by R. S. Blatchley.[12] This anticline extends from Belleville north to O'Fallon, and thence somewhat northeast, where it spreads out and loses its identity in this direction.

CHEMICAL VALUE OF COAL NO. 6 IN DISTRICT NO. VII

A detailed report on the chemical value of Illinois coals is being prepared by Prof. S. W. Parr for early publication as Bulletin 3 of this series, and in view of this fact, it is not regarded advisable to include a chemical discussion in this paper. It is the intention, therefore, to present only tabulated average analyses for the different coals of the State so that they may be easily compared.

In Plate IV the same analyses are presented in graphic form.

[12] *Blatchley*, R. S., Oil resources of Illinois: Bull. 16, Ill. Geol. Surv., pp. 42-177, 1910.

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TABLE 1.—*Average analyses of Illinois coals by districts*

(Figures are for coal as received)

Analyses by J. M. Lindgren under general supervision of Prof. S. W. Parr

District	Coal bed	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B. T. U.	Number of samples averaged
La Salle	2	16.18	38.83	37.89	7.08	2.89	10981	33 from 11 mines
Murphysboro	2	9.28	33.98	51.02	5.72	1.29	12488	15 from 5 mines
Rock Island and Mercer counties	1	13.46	38.16	39.75	8.63	3.59	11036	14 from 4 mines
Springfield-Peoria	5	15.10	36.79	37.59	10.53	3.52	10514	54 from 17 mines
Saline County	5	6.75	35.49	48.72	9.04	2.92	12276	27 from 7 mines
Franklin and Williamson counties	6	9.21	34.00	48.08	8.71	1.53	11825	58 from 16 mines
S. W. Illinois west of Duquoin anticline	**6**	**12.56**	**38.05**	**39.06**	**10.33**	**4.01**	**10847**	**76 from 25 mines**
Danville: Grape Creek Coal	6	14.45	35.88	40.33	9.34	2.55	10919	31 from 4 mines
Danville: Danville coal	7	12.99	38.29	38.75	9.98	2.93	11143	18 from 2 mines

PART II—COUNTY REPORTS

INTRODUCTION

It is believed that the reader can secure most satisfactory information from a report which is divided into units that can be considered separately. It is the plan, therefore, to present the facts regarding the coal resources of Illinois, not only in a general way for a district, but also for each county as a unit. Upon the completion of the separate district reports they will be combined into a volume with additional papers on features of general importance.

BOND COUNTY

Production and Mines

Production[1] in tons, year ending June 30, 1913.... 231,999
Average annual production, 1908 to 1913.......... 143,358
Total production 1881 to 1913....................3,160,126

The production of coal from Bond County for the year ended June 30, 1912, was slightly more than 3/10 of 1 per cent of the total production of Illinois. Only two mines operate in the county—the Pocahontas Mining Company at Pocahontas and the Northern Coal & Supply Company at Sorento. Coal No. 6 is worked in both.

Table 2.—*List of shipping mines, Bond County, 1913*

Map No.	Company	No. or name	Location ¼	Location ¼	Location Sec.	Location T. N.	Location R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	Average thickness In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Pocahontas Mining Co.	1	NE	SW	3	4	4	500	380	120	7	6	139,783
2	Northern Coal & Supply Co.		SE	SW	31	7	4	609	385	212	6	..	92,216

Coal-bearing Rocks

The coal-bearing rocks of Bond County vary in thickness from 700 to 900 feet. The upper half consists largely of shales and is barren of workable coals. Bed No. 6 is reached between 370 and approximately 460 feet below the surface, and the main coals lie within

[1]Statistics from Coal Repts., Ill. State Mining Board.

a zone 200 feet in thickness, the top of which is represented by coal No. 6.

The lower part of the "Coal Measures" is more sandy, and in the vicinity of Greenville considerable salt water is reported from a sandstone of variable thickness which lies at a depth of about 700 feet. This sandstone reaches a thickness of almost 200 feet in a few of the deep holes, although the average is between 50 and 100, and in some places shales are interbedded with the sandstone.

The sandstones at the base of the coal-bearing beds are productive of oil and gas at Carlinville, and were formerly productive at Litchfield. Indication of oil and gas are reported from a well in sec. 16, T. 5 N., R. 4 W. owned by the Producers Oil Company, the log of which is given below.

Record of Producers Oil Company

Location—SW.¼ NE.¼ sec. 16, T. 5 N., R. 4 W.

Description of Strata	Thickness *Feet*	Depth *Feet*
Quaternary system—		
Recent—		
Clay	89	89
Mud, blue	41	130
Carboniferous system—		
Pennsylvanian Series—		
McLeansboro formation—		
Limestone	10	140
"Slate" and blue mud	110	250
Sand (hole full of water)	100	350
"Slate"	50	400
Mud, blue	35	435
Carbondale formation—		
Coal (No. 6)	8	443
"Slate"	47	490
Limestone	20	510
Shale, blue	105	615
Pottsville formation—		
Sand, gas	19	634
Shale, black, and mud	34	668
Sand (show of yellow oil, 2 quarts to 1 bbl. water)	14	682
Shale, black	8	690
Sand,	20	710
Shale	20	730
Sand	10	740
Shale, black	10	750
Mud, white	28	778
Sand, pebbles (½ bailer of oil at 778 feet, 4 bailers of water second screw at 785 feet)	20	798
"Slate"	12	810
Shale	10	820

Description of Strata	Thickness *Feet*	Depth *Feet*
Mississippian series		
Chester group—		
Red rock, cave	20	840
Limestone shells	3	843
Red rock	10	853
Sand	5	858
Shale	57	915
"Slate," white	25	940
Limestone	3	943
Red rock	17	960
Sand (hole full of water)	15	975
Red rock, cave	7	982
Sand	6	988
Red rock	10	998
Limestone	5	1003
Sand (water)	10	1013
Red rock, cave	2	1015
Sand	10	1025
Osage and Meramec ("big lime") groups—		
Limestone (hole full of water at 1,040 feet)	480	1505
"Slate"	15	1520
Limestone	8	1528
Kinderhook and Upper Devonian (?) shales—		
"Slate" and shells	490	2018
Silurian system—		
Alexandrian limestone—		
Limestone	30	2048
Ordovician system—		
Maquoketa shales—		
"Slate" and shells	70	2118
Kimmswick-Plattin (Trenton)—		
Sand and limestone, hard (no oil)	32	2150
Limestone	5	2155

Well completed February 24, 1911

The lowest beds of the "Coal Measures" overlie a series of interbedded thin limestones, sandstones, and shales, some of the latter being distinctly red. The series, known as the Chester, attains a thickness of about 300 feet in Bond County, but toward the western side of the county it thins and in places is not more than 100 feet thick.

The following logs are published to furnish detail regarding the character of the coal-bearing rocks:

Log of Bond County Gas Company Well

Location—Sec. 22, T. 5 N., R 3 W.

Description of Strata	Thickness *Feet*	Depth *Feet*
Soil and clay, yellow, soft (water)	90	90
Sand and gravel, brown, soft (water, fresh)	70	160
Lime, white, soft	2	162

Description of Strata	Thickness *Feet*	Depth *Feet*
Sand, green, soft	8	170
Lime, blue, hard	3	173
"Slate," black, soft (fresh water)	10	183
"Slate," blue, soft	55	238
Lime, white, soft (fresh water)	10	248
"Slate," white, soft	50	298
Sand, white, soft, loose (salt water)	30	328
"Slate," white, soft	25	353
"Slate," blue, soft	30	383
Red rock, red, soft	5	388
"Slate," white, soft	10	398
Mud, yellow, soft	10	408
Lime, white, hard	20	428
Coal (No. 6), black, soft	4	432
"Slate," black, soft	16	448
Lime shells, white, hard	15	463
Sand, white, soft	30	493
Coal, black, soft	4	497
"Slate," white, soft	48	545
Shale, black, soft	15	560
Shale, brown, soft	15	575
Lime, blue, very hard	8	583
Coal, black, soft	3	586
Sand, white, soft (some water)	24	610
Shale, brown, sandy and soft	30	640
Sand, white, soft (3 bad holes)	75	715
Mud, black, soft (hole full water)	20	735
Lime, blue, hard	4	739
"Slate," white, soft	10	749
Lime, white, hard	10	759
"Slate" and lime shells, white, hard	15	774
Mud, black and soft	10	784
"Slate," white, pink, soft	24	808
Red rock, soft	12	820
Coal blossom, black, soft (water)	5	825
"Slate," white, soft	5	830
"Slate," black, hard	10	840
Red rock, red, soft	12	852
"Slate," black, hard	8	860
Lime, white, hard	4	864
"Slate," white, soft	8	872
Lime, white, hard	22	894
"Slate," black, cave	20	914
Lime, white, hard	2	916
Red rock, red, soft	4	920
"Slate," black, hard	12	932
Sand (1st Lindley), white soft (gas at 935 to 940)	34	966
"Slate," black, soft (water at 950)	4	970
Sandy lime, white, hard in bottom, top soft	30	1000
"Slate," white, soft	3	1003

Description of Strata	Thickness Feet	Depth Feet
Sand lime, brown, very hard	10	1013
"Slate," white, soft	12	1025
Red rock, red, soft (gas at 1049)	15	1040
"Slate," black, hard (gas at 1052)	8	1048
Sand, (2nd Lindley), white, hard	6	1054

Record of Lumaghi Coal Co.

Location—SW.¼ SW.¼ sec. 26, T. 7 N., R. 4 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sand, gravel, clay, lime	82	..	82	..
Fire clay	8	6	90	6
Lime, sandy	9	6	100	..
Lime, hard, brown	8	6	108	6
Shale, blue	1	6	110	..
Shale, black	1	..	111	..
Fire clay	11	..	122	..
Shale, light	15	..	137	..
Coal	2	6	139	6
Fire clay	3	6	143	..
Shale, light	27	..	170	..
Lime, sandy	4	..	174	..
Shale, sandy	8	..	182	..
Rock	4	..	186	..
Shale, light	25	..	211	..
"Slate," black	1	6	212	6
Lime	2	..	214	6
Shale, blue	12	..	226	6
"Slate," blue	9	6	236	..
Coal	2	..	238	..
Fire clay	2	..	240	..
Sandy shale	82	..	322	..
Shale, light	20	..	342	..
Lime, sandy	4	..	346	..
Shale, light	6	..	352	..
Shale, red	2	..	354	..
Shale, yellow	4	..	358	..
Shale, blue	13	..	371	..
Lime	10	..	381	..
Clay, blue	4	..	385	..
"Slate," black	2	..	387	..
Coal (No. 6)	7	9	394	9
Fire clay	..	5	395	2
Lime				

Record of H. R. Ameling, hole No. 1
Location—Center SW.¼ SE.¼ sec. 12, T. 6 N., R. 5 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Clay, yellow	7	..	7	..
Sand and clay	9	..	16	..
Shale, brown	2	..	18	..
Shale, dark	7	..	25	..
Sandstone	2	..	27	..
Shale, dark	59	..	86	..
Limestone, gray	7	6	93	6
Shale, black	31	..	124	6
Coal	1	..	125	6
Shale, dark	52	6	178	..
Limestone	4	..	182	..
Shale, dark	39	..	221	..
Sandstone, soft	13	..	234	..
Shale, dark	81	..	315	..
Shale, red	1	..	316	..
Shale, blue	8	..	324	..
Shale, mixed	11	..	335	..
Limestone	4	..	339	..
Shale, dark	15	..	354	..
Coal	1	..	355	..
Shale, dark	13	..	368	..
Limestone decomposed	3	..	371	..
Limestone	3	..	374	..
Coal, no cores	4	6	378	6
Coal	1	..	379	6
Shale, dark	5	..	384	6
Shale, gray	7	2	391	8
Shale, dark	18	..	409	8
Shale, blue	3	4	413	
Sandstone, gray	1	3	414	3
Shale, dark	2	..	416	3
Shale, gray	4	9	421	
Shale, light blue	25	..	446	
Shale, dark	36	..	482	

GEOLOGIC STRUCTURE

The geologic structure of the beds as indicated by the position of coal No. 6 has been described in a general way on page 33. Bond County contains parts of four major structural features—Sorento dome, Ayers anticline, Stubblefield anticline, and the Irishtown anticline.

Coal No. 6 lies highest above sea level in the extreme northwestern corner of the county where its altitude is between 200 and 250 feet above sea level. The general dip to the south and east carries the coal 20 feet below sea level in the southeast corner of the county.

Despite the dip, the depth of the coal beneath the surface does not increase regularly because the surface slopes gradually toward the south and east and counteracts the effect of the dip.

The Ayers anticline already described lies in the northern part of the county, its axis extending almost east and west through T. 6 N., Rs. 2, 3, and 4 W.

Four miles north of Greenville coal No. 6 is 165 feet above sea level or about 80 feet higher than at Greenville. The coal continues low to the west and at Old Ripley averages 75 feet above sea. From this place the beds rise towards the south, and coal No. 6 reaches an altitude of 179 feet in the NE. cor. sec. 32, T. 5 N., R. 4 W. on the Stubblefield anticline. There appears to be a depression of minor importance between the fold named immediately above and the Irishtown anticline. The axis of the latter extends northwest-southeast through the southeast part of T. 4 N., R. 4 W. and the southwest part of T. 4 N., R. 3 W.

The structure in the southeast quarter of the county is characterized by a gradual dip in this direction. The elevations of the coal in the southwest corner of the county were computed by J. A. Udden from surface outcrops of limestone and it is possible that the degree of dip to the south is somewhat exaggerated.

Coal No. 6

Coal No. 6 is commercially the most important bed in the county. So far as known, it is present under the entire county except a few sections in the eastern part of T. 6 N., R. 5 W. It appears to be absent in sec. 23, and is represented by a 1-foot bed in sec. 24. This "spotty" territory is part of a larger area shown on Plate I in Christian, Montgomery, and Bond counties, in which coal No. 6 is extremely irregular and "pockety." Many holes show it to be absent, whereas others indicate a normal thickness. It is believed that this development is the result of topographic conditions at the time the coal was being deposited. An irregular arm of land, rising here and there slightly above the level of the swamp in which the vegetal matter was growing, and having the general outline indicated on the map, would cause such an irregular absence of coal.

Another and equally reasonable theory attributes the absence of the coal to erosion after deposition. In some holes which do not show coal No. 6, the normal limestone cap rock also is absent. It is probable that after the deposition of the coal of some of the overlying beds, this part of the State existed as a land surface upon which the drainage cut channels to varying depths and locally removed the coal completely. The following log illustrates such a condition.

Record of H. R. Ameling hole No. 3

Location—Sec. 23, T. 6 N., R. 5 W.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Clay	14	..	14	..
Sand	2	..	16	..
Clay	8	..	24	..
Shale, blue	8	..	32	..
Shale, sandy	..	10	32	10
Shale, sandy, with streaks of sandy limestone	9	2	42	..
Shale, gray, sandy	12	..	54	..
Shale, dark	17	..	71	..
Limestone, gray	6	..	77	..
Shale, blue	19	..	96	..
Limestone, gray	6	10	102	10
Shale, dark	1	2	104	..
Shale, black	1	6	105	6
Shale, gray	16	6	122	..
Shale, gray, with black streaks	14	..	136	.
Shale, sandy, gray	15	..	151	..
Shale, gray, with streaks of brown limestone	15	..	166	..
Shale, dark gray	2	2	168	2
Coal	..	10	169	..
Shale, dark gray, sandy	27	..	196	.
Sand, gray, streaked with shale	3	10	199	10
Limestone, gray	.	8	200	6
Shale, dark	30	6	231	..
Shale, dark, sandy	10	..	241	..
Sand, white	25	.	266	.
Shale, dark, sandy	7	..	273	..
Sand, white	32	..	305	
Shale, dark	7		312	
Shale, variegated	15	.	327	
Shale, dark	2		329	.
Limestone, gray	5	6	334	6
Shale, dark	1	6	336	
Shale, blue	4	.	340	.
Streaks of blue shale, gray limestone and white sand	20		360	
Sand, white (place of coal No. 6)	10		370	
Shale, dark, sandy	5		375	
Sand, white	5		380	
Shale, dark	3		383	
Sand, white	32		415	.
Sand, white, with streaks of coal	10		425	.
Shale, dark, sandy	3	.	428	.
Sand, white	18		446	
Shale, dark sandy	5	.	451	

With the exception of the southeast quarter of the county and the small area mentioned above, coal No. 6 averages 7 feet in thickness, which is the average for the coal in the district. Nine holes in the eastern half of T. 5 N., R. 3 W. in the vicinity of Greenville show an average thickness of 3 feet 2 inches for coal No. 6. At Smithboro in the next township east it is 3 feet, which is the thickness reported in two holes located in secs. 20 and 35, T. 4 N., R. 2 W.

Coals below No. 6

Most of the prospect holes are stopped in the fire clay underlying coal No. 6, hence this coal is fairly well known; whereas those below are but little explored. Tests in sec. 12, T. 6 N., R. 5 W. were continued 120 feet below coal No. 6 without passing through any other commercial coal. One log in this section shows streaks of coal 50 feet below coal No. 6, and another reports a 6-inch bed 105 feet below the same horizon. About 20 holes have been drilled for oil in Bond County, and in only 6 of these are noted coals other than No. 6. It must be remembered that the oil prospects are made by the churn drill, and measurements are not so accurate as with the diamond drill. Since the main interest is oil, the resulting coal data are probably inaccurate, but they comprise the best available information for the beds below coal No. 6.

Although all of the holes in which lower coals are reported are in the vicinity of Greenville, correlation of the different beds is a difficult matter owing to the variability of the intervals between the coals. In sec. 9, T. 5 N., R. 3 W. a 6½-foot bed is reported to lie 200 feet below coal No. 6 at a depth of 625 feet. A 6-foot bed is noted occupying the same position at the same depth in sec. 26 of this township. A similar bed is reported in sec. 22, 180 feet below coal No. 6. It is possible that this bed represents No. 2 and that the interval between coals No. 2 and No. 6 is somewhat less than to the south. In secs. 22 and 26, T. 5 N., R. 3 W. a bed of coal from 3 to 4 feet thick is found from 60 to 70 feet below No. 6. This bed is probably to be correlated with coal No. 5 which is mined in the Springfield region. In sec. 23 a 5-foot bed is reported 100 feet below coal No. 6. It is not represented in any of the other logs and its correlation is doubtful.

CLINTON COUNTY

Production and Mines

Production in tons, year ending June 30, 1913.....1,036,303
Average annual production 1909 to 1913..........1,020,373
Total production 1881 to 1913..................16,032,809

Clinton County ranked 17 in 1913 having a production of 1.7 per cent of the entire Illinois output. Five shipping mines were in operation, all working coal No. 6.

TABLE 3.—*List of shipping mines, Clinton County, 1913*

Map No.	Company	Mine name or No.	Location ¼	¼	Sec.	T. N.	R. W.	Surf. elev.	Depth of coal No. 6	Alt. top coal No. 6	Average thickness Ft.	In.	Production, 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Southern Coal, Coke & Mining Co.	9	NW	SW	17	1	5	454	319	135	8	..	367,619
2	Breese-Trenton Mining Co.	East	..	NE	22	2	4	450	400	50	7	6	236,885
3	North Breese Coal Mining Co.	North	SW	NE	23	2	4	442	392	50	7	6	235,096
4	Consolidated Coal Co.	West	..	NE	21	2	4	457	394	63	7	6	120,186
5	Breese-Trenton Mining Co.	Buxton	..	NE	21	2	3	458	432	26	8	..	76,517

COAL-BEARING ROCKS

The coal-bearing rocks of Clinton County, which are covered by an average thickness of 100 feet of drift, vary in thickness from 500 to 1000 feet, the larger sections lying in the eastern part where the eastward dip has been effective in carrying all of the beds deeper beneath the surface. The Shoal Creek limestone, which is described on page 25, is well exposed along Shoal Creek and its tributaries. It appears to be fairly persistent over the county east of its boundary, and lies from 250 to slightly more than 300 feet above coal No. 6.

No coals of commercial importance exist above No. 6. A thin bed from 150 to 180 feet above coal No. 6, is noted in places. This bed, which is seldom reported to be more than 15 inches thick, is probably to be correlated with coal No. 8. Scattered records show a thin bed representing coal No. 7 between 25 and 35 feet above coal No. 6. It contains bands of "slate" and sulphur amounting here and there to definite partings and separating the bed into at least two benches. In sec. 12, T. 1 N., R. 1 W. the entire bed measures 2 feet 8 inches, but its average is between 1 and 2 feet.

Most of the logs show a limestone of varying thickness immediately overlying, or slightly above, coal No. 6. In places the limestone rests on the coal, but in most places a shale of varying thickness intervenes. The Buxton mine at Beckemeyer has black shale roof which attains a thickness of 4 feet, although here and there it is absent, and

the limestone immediately overlies the coal. Typical sections in this county show a dark or black shale of variable thickness containing "niggerheads" and forming the roof of the coal. Above this is a limestone which may be separated into two or more benches, the combined thickness averaging less than 10 feet.

The following logs are from holes in different parts of Clinton County:

Well Record of Germantown Flour Mills

Farm and well—Schurman No. 1. Location—Sec. 8, T. 1 N., R. 3 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil	1	..	1	..
Clay, sandy	19	..	20	..
Sand and gravel, partly cement	30	6	50	6
Clay, blue, gravelly	30	6	81	..
Shale, blue	1	..	82	..
Limestone	6	7	88	7
Shale, blue	2	9	91	4
Shale, black	2	8	94	..
Shale, dark; one hard layer	10	2	104	2
Coal, bony	..	4	104	6
Coal	..	6	105	..
Shale, soft, light	7	..	112	..
Shale, sandy	19	..	131	..
Shale, blue	28	..	159	..
Shale, light	13	..	172	..
Shale, sandy	4	..	221	..
Sandstone	25	..	246	..
Sandstone, coal parting	5	..	251	..
Shale, blue	19	6	270	6
Sandstone	4	10	275	4
Conglomerate	6	..	281	4
Shale, blue	..	5	281	9
Shale, dark	7	..	288	9
Shale, dark blue, hard bands	5	3	294	..
Shale, gray	16	..	310	..
Shale, dark blue, hard bands	31	9	341	9
Shale, black	..	3	342	..
Clay shale	1	3	343	3
Limestone	3	..	346	3
Shale, blue	10	..	356	3
Shale, black	..	9	357	..
Clay shale	6	6	363	6
Limestone	5	6	369	..
Shale, blue	5	6	374	6
Coal, bony	..	7	375	1
Clay	4	11	380	..
Coal, bony	1	..	381	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Clay shale	4	..	385	..
Limestone	7	6	392	6
Shale, dark	3	6	396	..
Limestone	1	..	397	..
Shale, dark	1	4	398	4
Limestone	3	..	401	4
Shale, dark	3	..	404	4
Limestone	1	..	405	4
Shale, dark	3	..	408	4
Limestone	1	6	409	10
Coal	6	..	415	10
"Blue band" No. 6	..	1	415	11
Coal	1	8	417	7
Clay	1	5	419	..

Well record of Gibson and Veitch

Farm and well—C. N. Dunn, No. 1.

Location—NE.¼ NE.¼ sec. 1, T. 1 N., R. 1 W.

Description of Strata	Thickness *Feet*	Depth *Feet*
Clay and sub soil	34	34
Gravel	6	40
"Slate"	21	61
Lime, very hard	15	76
"Slate"	49	125
Lime, very hard	15	140
"Slate" and lime shells	405	545
Lime, very hard, cap rock	31	576
Coal (No. 6)	6	582
"Slate"	63	645
Coal (No. 5)	4	649
"Slate" and thin lime shells	166	815
Upper salt water sand	40	855
"Slate" and thin lime shells	180	1035
Sand (water)	115	1150
"Slate" and lime shells	100	1250
Sand (water)	110	1360
Red Rock (cave)	10	1370
Limestone	11	1374
Oil sand	11	1385
Sand (water) from	98-1422	1520
Limestone	162	1682

Record of Trenton Coal Co., well No. 1

Location—sec. 29, T. 2 N., R. 5 W.

Description of Strata	Thickness		Depth	
Pennsylvanian series—	*Ft.*	*In.*	*Ft.*	*In.*
Clay, yellow	22	..	22	..
Clay, blue	20	..	42	..
Shale, blue	1	..	43	..
Shale, sandy	2	..	45	..
Shale, sandy	55	..	100	..
Sandstone, shale partings	22	..	122	..
Sandstone	47	..	169	..
Shale, blue	2	..	171	..
Sandstone	26	..	197	..
Sand and lime mixed	2	6	199	6
Sandstone	14	8	214	2
Conglomerate	..	8	214	10
Shale, blue	15	2	230	..
Lime shale	7	..	237	..
Shale, blue	20	..	257	..
Shale, blue, and lime pebbles	3	..	260	..
Limestone	2	..	262	..
Limestone, very hard	5	4	267	4
Shale, soft, blue	6	10	274	2
Limestone	4	5	278	7
Shale, sandy	8	5	287	..
Shale, blue	34	..	321	..
Coal, shaly	2	..	323	..
Coal (No. 6)	5	3	328	3
Fire clay	2	9	331	..
Limestone	5	8	336	8
Clay, shale, lime, pebbles	2	10	339	6
Lime shale	2	..	341	6
Sandstone	4	6	346	..
Shale, blue	20	..	366	..
Limestone	1	6	367	6
Shale, black	2	6	370	..
Coal (No. 5)	2	6	372	6
Fire clay	..	6	373	..
Sand shale	13	..	386	..
Lime shale	3	4	389	4
Limestone	..	6	389	10
Shale, blue	27	2	417	..
Shale, blue	2	4	419	4
Slate, black	..	8	420	..
Coal	..	9	420	9
Shale, blue	24	3	445	..
Shale, blue	2	4	446	4
Limestone	..	8	448	..
Shale, black	..	6	448	6
Fossiliferous	..	6	449	..

Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
Shale, black	3	3	452	3
Coal	5	..	452	8
Coal	1	7	454	3
Fire clay, soft	1	..	455	3
Clay shale	5	2	460	5
Shale, black	..	6	460	11
Coal, bony	1	9	462	8
Shale, soft	1	2	463	10
Coal, bony	9	..	464	7
Shale, soft dark	10	5	475	..
Shale, blue	68	..	543	..
Sandstone	8	2	551	2
Shale	..	10	552	..
Coal	1	..	553	..
Clay shale	3	..	556	..
Shale, blue	4	2	560	2
Sandstone	19	7	579	9
Mississippian series—				
Chester formation (upper part)—				
Limestone	..	3	580	..
Limestone	11	..	591	..
Sand shale	8	..	599	..
Sand and lime mixed	9	4	608	4
Clay shale	..	10	609	2
Limestone	..	6	609	8
Shale, red and blue, lime bands	4	4	614	..
Shale, red	..	6	614	6
Shale, blue	13	6	628	..
Limestone	9	4	637	4
Limestone shale mixed	3	8	641	..

The record just above shows no limestone or black shale near the coal. Such a condition is not rare, and is attributed to erosion after the deposition of part of the roof materials. More details will be given in the discussion of coal No. 6.

The coal-bearing rocks extend from 300 to 600 feet below coal No. 6, the variation in thickness being due to the deposition of the lowest Pennsylvanian sediments on a former land surface which was composed of hills and valleys larger than those of Illinois today. As a rule the lowest 200 feet of "Coal Measures" is more sandy than the upper part of the section. The Pottsville formation at the base averages 160 feet at Carlyle and thickens towards the south. It is composed of sandstones interbedded with shales. The sands are generally porous, and over most of the county the Pottsville is known as the "salt sand," because of the large amount of salt water contained.

The coals of commercial importance lie in a zone 250 feet thick, coal No. 6 being at the top. Most of the available logs for Clinton County are records of churn-drill holes bored in prospecting for petroleum. The data regarding the coals are rather meagre, especially for those below coal No. 6, which is mined and well known. These beds will be described so far as known under the subject "Coals below No. 6".

The "Coal Measures" overlie a series of limestones, shales, and sandstones known as the Chester group, which varies in thickness in Clinton County from 300 to 600 feet, and contains the producing oil sands at Carlyle. This series is most easily recognized by the presence of red shales, or "red rock" of the driller. These shales should not be confused with those lying in some places from 20 to 50 feet above coal No. 6, mentioned earlier in this report. The Chester contains no commercially valuable coal, and prospecting for this material should be discontinued upon reaching these beds. If identification is difficult, the detailed log of the well, or better still, samples from each screw (in the case of churn drilling) should be sent to the State Geological Survey. This office will be glad to make proper correlations and to advise the operator of the position of his drill in the stratigraphic section.

The following log is typical of the relation of the "Coal Measures" to the underlying Chester.

Well record of Siva Oil Co.

Location—NW.¼ sec. 5, T. 2 N., R. 5 W.

Description of Strata	Thickness *Feet*	Depth *Feet*
Pennsylvanian series—		
Clay	43	43
Lime	5	48
Shale, sandy	7	55
"Slate"	30	85
Lime	8	93
"Slate"	124	317
Lime	6	223
"Slate"	93	316
Red rock	4	320
"Slate"	15	335
Lime	10	345
"Slate"	5	350
Coal (No. 6)	7	357
"Slate"	39	396
Lime	2	398
"Slate"	86	485
Lime	5	490
"Slate"	70	560
Shale, sandy	87	647

Description of Strata	Thickness *Feet*	Depth *Feet*
"Slate"	13	660
Sand	12	672
"Slate"	10	682
Mississippian Series—		
Chester group (upper part)—		
Lime	18	700
"Slate"	8	708
Red rock	14	722
"Slate"	10	732
Lime	25	757
"Slate"	18	775
Lime	12	787
"Slate"	15	802
Lime	30	832
"Slate"	35	857
Sand	9	866
"Slate"	68	934
Red rock	9	943
Lime	10	953
Red rock	6	959
"Slate"	51	1010
Sand	120	1130
"Slate"	10	1140
Lime	11	1151

Geologic Structure

Clinton County lies on the west side of the Illinois coal basin, and the most noticeable feature of the geologic structure is a general eastward dip of the beds as shown by the attitude of coal No. 6. Along the western side of the county this coal is 180 feet above sea level; whereas on the eastern side it is as much as 150 feet below the sea, a difference of 330 feet. The eastward dip is not regular, but is interrupted by gentle folds, at least one of which has proved to be of economic importance. The Carlyle anticline described in Part I raises coal No. 6 to an elevation of 60 feet above sea level in the northwest corner of the Carlyle oil field. The axis of this fold extends northwest-southeast and differs in this respect from the axis of the fold in the oil sands 600 feet below the coal. The condition is due to the lack of parallelism between the sands and the coal. The coal is higher along the axis than to the north, east, or south.

The axis of the Irishtown anticline enters the county about the center of the north line of T. 3 N., R. 3 W., and extends a little south of east, until the fold loses its identity in T. 3 N., R. 2 W. In sec. 17 of this township the coal is 73 feet above sea level, 50 feet higher than in holes 4 miles to the north or south.

Several holes drilled by the Siva Oil Company in secs. 13, 24, and 25, T. 2 N., R. 5 W. are difficult to correlate with other holes in the vicinity. The coals are thin and irregularly developed in the different holes, and no definite structure is suggested. It was thought by some that because the main coal was found considerably higher above sea level in these holes, a dome had been proved to exist. It is believed by the author that faulting is responsible for the discrepancies, although the exact nature of the movements has not been determined.

The coal lies 60 feet above sea level in the northwest corner of sec. 7, T. 1 N., R. 3 W., one mile northwest of Bartelso. This altitude for coal No. 6 indicates that a dome exists, since the coal is lower in all directions from this point.

At Hoffman the top of the coal is 43 feet above sea level, almost as high as at Bartelso, 11 miles west, although the regular east dip would carry the coal much deeper. The rocks here are higher than to the west, north, or east. Their position to the south is not known. A wide shallow syncline appears to exist between Bartelso and Hoffman.

With the exception of the Aviston area, the structure appears to be fairly regular and free from major faulting.[1]

Several small faults exist in mine No. 9 of the Southern Coal and Mining Company, NW. ¼ SE. ¼ sec. 17, T. 1 N., R. 5 W. A few of these dislocations have been traced almost a mile. They trend from east-west to northeast-southwest and appear to split at different points. Figure 6 represents two persistent faults on the east side of

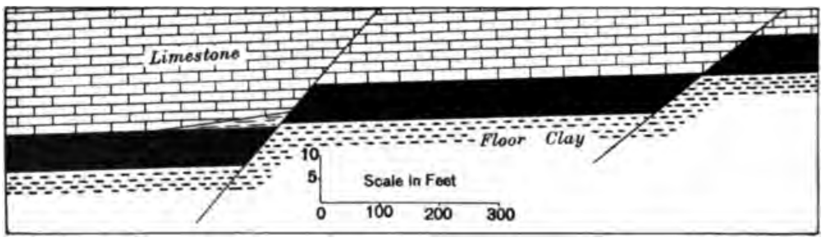

FIG. 6.—Sketch of faults on main east entry near parting, Southern Coal, Coke and Mining Co., mine No. 7, New Baden, Clinton County.

the mine. They are northeast-southwest fractures, along the northwest side of which the strata have dropped about 8 feet, practically the thickness of the coal. Other than a slight shattering of the coal near the fracture, the effect is small and consists in causing steep

[1]The term *fault* in this report signifies an actual fracture along which vertical or horizontal movement has occurred. It does not refer to erosion channels, clay veins, or "*horsebacks*" often called "faults" by the miner.

grades for haulage. Small faults of a similar character were found in the West mine at Trenton.

Small irregularities in the dip exist in most of the mines and are known to the miners as "sags" and "hills". They consist of dips which continue comparatively short distances, and then change to the opposite direction. Figure 7 shows the track profiles (approximately

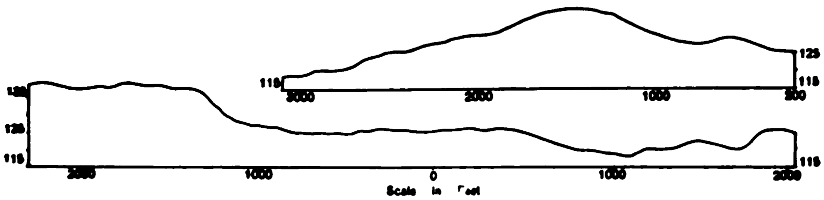

FIG. 7.—Track profiles in parts of Southern Coal, Coke and Mining Co., mine No. 9, New Baden, Clinton County.

the base of coal) in parts of the New Baden mine. Local hills and valleys give a relief of 15 feet to the coal in a distance of 400 to 800 feet and the irregularity of the dip is well illustrated in the cut. These features appear to have no definite trend and may be related to the floor upon which the original vegetal matter was deposited. It is difficult to believe that regional movements have produced features so small in extent.

The chief effect of these irregular dips is additional haulage expense. In a few mines in the State, as in the Jeffrey mine near Herrin, the hills are so steep that the maintainance of a suitable grade for the track requires more than ordinary expenditure. No serious difficulty of this kind is reported in Clinton County.

COAL No. 6

DISTRIBUTION AND DEPTH

Coal No. 6 ("blue band") is represented throughout the entire county, although its thickness varies. It is nearest the surface on the western side of the county where it lies at a depth of 320 to 350 feet. Its gradual east dip carries it to depths between 500 and 575 feet in the eastern part of the county. The arching of the beds in the vicinity of Hoffman counteracts the effect of the regular east dip and brings the coal almost 100 feet nearer the surface than would otherwise be expected.

The deepest shaft in the county, that of the Breese-Trenton Mining Company's Buxton mine at Beckemeyer reaches the bottom of coal No. 6 at 440 feet. Fortunately sufficient drilling has been done to enable one to outline the areas of thin coal with some success. N

present mining operations are carried on at New Baden, Breese, and Beckemeyer, the mines being located along the railroads and in areas where the coal averages 7 to 8 feet in thickness.

THICKNESS OF COAL NO. 6

In an irregularly shaped area of about 35 square miles in the vicinity of Aviston (see Plate I in pocket), coal No. 6 is either absent or much below normal thickness. In this area 8 holes give an average thickness of slightly less than 3 feet for this bed. It should be remembered that most of these holes were made by the churn drill and that the measurements are not uniformly accurate. However, it is certain that the coal does not attain its normal thickness and it is probable that this area is the southward extension of the more or less barren area at Highland, Madison County, and north in parts of Montgomery and Bond counties, described earlier in the report and more in detail in the reports for the counties named. In Clinton County, this area is roughly rectangular, its long axis extending about N. 30° W. through the town of Aviston, which is near the center of the area. Its length is about 8 miles in Clinton County and its average width, about 4 miles. A drill hole located in sec. 34, T. 2 N., R. 4 W. is the only one in which coal No. 6 is absent; in the others it is merely much thinner than normal.

Another roughly rectangular area of thinner coal approximately 100 square miles in extent lies in the eastern part of the county. Its width is about 8 miles, a little greater than the distance from Carlyle to Hoffman, and its long dimension in Clinton County is about 14 miles (see Plate I). So far as known definitely from present data, the southern boundary of this area is represented by a line connecting Carlyle and Hoffman, and its long axis extends about N. 15° E. through the north line of the county. It is entirely probable that this area of thinner coal continues to the south through Washington County, into Perry, and across the line east into Jefferson County, but drill holes are too scattered to permit the safe drawing of definite boundaries for thick and thin coals in the counties just mentioned. Even in Clinton County the line is tentative and will no doubt be changed by the results of future drilling. It is probable that small areas will be found inside the boundaries indicated where coal No. 6 reaches its normal development, but available information indicates the probable irregular nature of the coal within such lines.

To the west and southwest of the "spotty" area near Aviston the coal varies in thickness from 5 feet to 8½ feet, the average being 6 feet 10 inches in 8 holes scattered over the western parts of Tps. 1 and 2 N., R. 5 W. In the central part of the county, between the

two areas of thinner coal, its average thickness is 7 feet. This area contains the mines at Beckemeyer and at Breese. In mine No. 10 of the Southern Coal and Mining Company at Germantown coal No. 6 ranges in thickness from 4 feet 6 inches to 5 feet 2 inches. It is reported that a 2-foot 4-inch bed exists at a distance of 5 or 6 feet below coal No. 6 and that the two beds together represent the "blue-band" coal, the interval between being merely a parting. This information is not confirmed or disproved by logs in the Survey office, the only similar suggestion being an unsupported statement that at the mill in New Baden about 8 miles southwest of Germantown, the coal is divided into two benches by a 2-foot parting of shale. Such a division is not known at the New Baden mines, a short distance away. The extreme eastern part of the county is directly connected with the Centralia field across the line in Marion County. The few holes that have been drilled here indicate an average thickness of 6 feet for coal No. 6.

PHYSICAL CHARACTER OF COAL NO. 6

The physical character of the coal is best determined at the face in mines where a large area is exposed to view. Figure 8 shows the general characteristics of coal No. 6 in Clinton County. This coal exhibits the usual characteristics of the bed over the district. It is separated into three benches which are uniformly recognizable. At New Baden the bed averages 8 feet 4 inches in thickness. A charcoal parting about 2 feet from the roof separates the middle bench from the top coal which is generally bright and hard and contains but little dirt. In places a few small vertical streaks of pyrite cut through the upper part of the bed.

The middle bench, about 4½ feet thick, extends from the parting mentioned above, down to the "blue band", a clay containing some pyrite and averaging 1 to 1½ inches in thickness. This bench consists of alternate layers of bright and dull coal, also bands of dirt, charcoal, and pyrite. Individual bands of impurities are generally lenticular and can not be traced throughout the mine, but it is not unusual to find two more or less persistent streaks of pyrite in the middle bench. In the mine mentioned above two such bands are known, each about ¼ inch thick, the upper one about 15 to 18 inches below the top coal parting, and the other 12 to 18 inches lower. Because of their hardness the pyrite streaks are often called "steel" bands by the miner, and where such streaks are persistent the placing of shots is governed to some extent by their position, in order to take advantage of the parting which they afford.

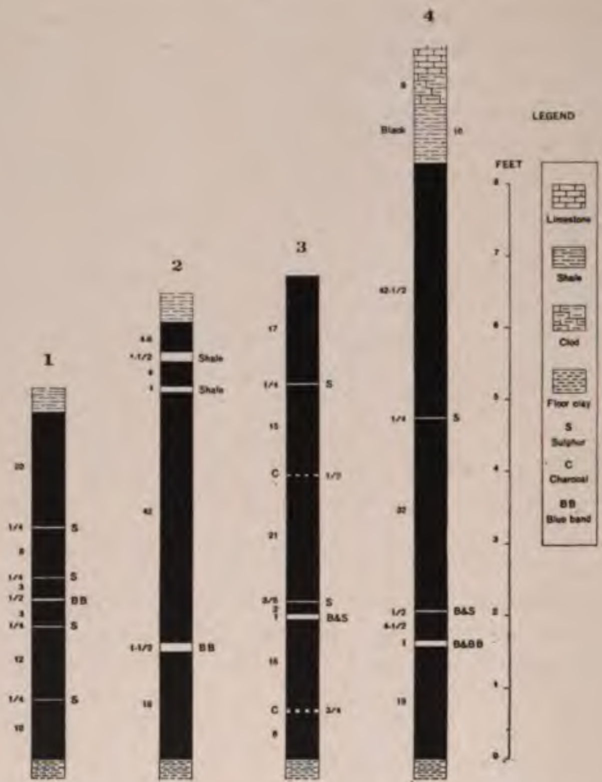

Fig. 8.—Graphic sections of coal No. 6 from measurements made in mines of Clinton County. (B indicates "bone.")

1. Southern Coal Co., mine No. 10, Germantown (abandoned). 9th W. off 1st. N., 2200 feet from shaft.

2. Trenton Coal Co., mine No. 1, Trenton (abandoned). Room 1, 2d E., north side.

3. Breese-Trenton Mining Co., Beckemeyer. Face 3d E. off N.

4. Southern Coal, Coke and Mining Co., New Baden. 6th N. off main east entry.

The bottom bench measures from 17 to 24 inches. It consists in most places of harder coal than the middle and tends to contain a higher percentage of dirt. A dull appearance due to the large amount of impurities present is common.

In the fracture planes of the coal small amounts of calcium carbonate have been deposited and now appear as white scales. Irregular balls of pyrite exist in some of the mines, but not so plentifully as to cause special trouble in mining.

The general conditions at Beckemeyer agree with those just described except in measurement detail. The top coal is 18 inches thick.

and a small pyrite band commonly lies about 20 inches below the top of the middle bench. The "blue band" averages 5 or 5½ inches in thickness. In places it is in two parts separated by an inch or two of clean coal. In others the upper part consists of bone and coal and the lower part is a mixture of gray shale and pyrite.

The following table shows the measurements on coal No. 6 made at different mines in Clinton County.

TABLE 4.—*Mine measurements of the three benches composing coal No. 6 in Clinton County*

Company	Mine	Top coal		Middle bench		"Blue band"	Lowest bench
		Ft.	*In.*	*Ft.*	*In.*	*Inches*	*Inches*
Southern Coal, Coke & Mining Co.	No. 9	2	..	4	6	1 to 1½	20 to 24
Breese Trenton Mining Co.	Buxton	1	6	4	6	3 to 5½	24
Trenton Coal Co.	No. 1 (South mine)	..	4 to 5	4	7	1½	18
Cooperative Coal & Mng. Co.	1	..	..	..	..	2	14
Southern Coal Co.	10	1	8	..	11¼	½	26

The thin top coal of the South mine at Trenton and the 11¼-inch middle bench of Southern Coal Company No. 10 at Germantown are the principal irregularities in the mines examined in the county. Neither of these mines produced any coal during 1912-13.

ROOF AND FLOOR

Throughout most of the county a good limestone cap rock lies above the coal. It ranges from 5 to 15 feet in thickness and in places is separated into several beds by small layers of shale. This is the persistent limestone which contains the little fossil called *Fusulina cylindrica*. It is about the size of a grain of wheat, and its presence enables the geologist to identify the bed in places where coal No. 6 is absent. Here and there the limestone rests directly on the coal, but in many places a black shale, called "slate" by the miner, intervenes between the cap rock and the coal. In most of the mines both conditions are known; the mines at Trenton have a 40-foot soft shale roof and are exceptions to the general rule. Such a condition suggests that the original limestone and black shale roof was removed by erosion after having been deposited, and was later replaced by the softer shale. Absence of the limestone cap rock is indicated in some

of the drill holes of Tps. 1 and 2 N., R. 5 W. and in the southeastern part of T. 2 N., R. 3 W.

In the north part of the Germantown mine the black slate attains a thickness of 5 feet; whereas near the shaft only a thin parting of slate separates the coal from the limestone. Mine No. 9 of the Southern Coal, Coke, and Mining Company at New Baden has the limestone roof except in a limited area on the west side, where black shale overlies the coal. Throughout the mine about 3 inches of an irregularly bedded calcareous shale called "clod" directly underlies the limestone.

The black shale is sheety and requires much timbering. In places the coal adheres to the shale, and since a clean parting lies 7 inches below the top of the coal, this much of the bed is left up for roof where separation of shale and coal is not easily made. The limestone roof requires no timbering.

In the Buxton mine at Beckemeyer black shale as much as 4 feet in thickness and containing many niggerheads is the regular roof. In only a few places does the limestone come into contact with the coal. To protect the shale and to render mining conditions more satisfactory, about 18 inches of coal is left up for roof.

About 200 feet northeast of the shaft bottom, an irregularly bedded, gray, calcareous shale replaced the normal roof in a small area which appears to have been subject to erosion subsequent to the deposition of the beds some distance above the coal. Part of the coal itself was eroded and the depressions are filled with a conglomerate, some of the pebbles of which are coal. Because of the unconsolidated nature of the material, much of it falls; and in the summer of 1912 the top of the fall was 30 feet above the roof of the coal.

The normal floor material is clay, which is reported in the mines to be from 18 inches to 8 feet thick. In most places it rests on shale, but in a few places a bed of limestone is reported to lie a few feet below the coal. The clay varies greatly in character from place to place and even in the same mine. Its color varies from light gray to almost black, depending on the amount of carbonaceous matter contained. In most places the clay slacks on exposure to the air, and where considerable moisture exists the floor materials are squeezed up into the rooms and entries by the pressure of the overlying strata.

Coals below No. 6

Despite the many holes drilled in Clinton County, the coals below No. 6 cannot be regarded as thoroughly prospected. Most of the holes were made by the churn drill and were put down in search of

petroleum; hence details regarding the coals were of minor interest to the operators and drillers.

In the vicinity of Trenton a 2½-foot coal is reported 42 feet below coal No. 6 in a position corresponding to coal No. 5. Thin coals have been noted at a similar horizon in sec. 17, T. 1 N., R. 5 W. in secs. 13, 29, T. 2 N., R. 3 W., and in sec. 1, T. 1 N., R. 1 W., but most of the logs make no note of such a coal, a fact indicating a "spotty" development of this bed. A recent diamond-drill hole in sec. 12, T. 1 N., R. 1 W., shows a 3-foot 11-inch coal 110 feet below coal No. 6. The interval between the two appears to be too great to render safe the correlation of the lower bed with coal No. 5. In Saline County such an interval exists, but in Williamson and Franklin counties these coals are but 40 to 50 feet apart. Information is too meagre to correlate satisfactorily the 3-foot 11-inch bed in sec. 1.

The only other bed of promising nature in the county lies from 200 to 250 feet below coal No. 6 in proper position to be correlated with coal No. 2. In sec. 25, T. 2 N., R. 5 W. this bed is 485 feet below the surface and is reported to be 4 feet thick. It is found in sec. 12, T. 1 N., R. 1 W. at a depth of 642 feet and is 10 inches thicker than in the last hole mentioned. This is apparently the bed reported by the Centralia Coal Company NW. ¼ NW. ¼ sec. 19, T. 1 N., R. 1 E. at a depth of 774 feet. At this place the bed reaches a thickness of 6 feet 11 inches. This coal is reported only in the holes mentioned, and its existence over most of the county is extremely doubtful. It probably exists in disconnected areas or pockets which in the future may yield considerable tonnage. It is significant that this coal is reported almost exclusively in diamond-drill holes, and it is possible that its existence has been overlooked in parts of the county tested only by the churn drill.

A few thin beds are reported here and there between coals No. 2 and No. 6, but they are not persistent and appear to be lenticular deposits covering small areas and are of no commercial value.

CHRISTIAN COUNTY

Production and Mines

Production in tons year ending June 30, 1913....	1,481,737
Average annual production 1909 to 1913........	1,346,479
Total production 1881 to 1913.................	22,794,343

Christian County has ranked 14 in production since 1909. Its output for 1913 was 2.5 per cent of that for the entire State. The following table shows the rank of the operating mines for 1913.

TABLE 5.—*List of shipping mines, Christian County, 1913*

Map No.	Company	Mine name or number	Location ¼	Location ¼	Location Sec.	Location T.	Location R.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	Average thickness In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Christian County Coal Co.			NE	33	13N	2W	609	472	137	7	8	341,112
2	Springfield Coal Mining Co.	6	SW	NW	26	13N	2W	610	480	130	8	..	240,247
3	Stonington Coal Co.		SE	NE	28	14N	1W	610	478	132	7	..	239,938
4	Penwell Coal Company	1		NE	21	11N	1E	696	728	-32	7	..	197,627
5	Pana Coal Co.	1	SE	SE	16	11N	1E	695	722	-27	8	..	166,564
6	Smith Lohr Coal Mining Co.		cen	ter	15	11N	1E	681	720	-39	7	6	100,303
7	Illinois Midland Coal Co.	7	SW	NW	14	13N	3W	575	347	228	7	6	74,824
8	Assumption Coal & Mining Co.		W	SE	2	12N	1E	644	659	-15	1	6	......
	Coal No. 2 (?)								987	-343	3	..	73,883
	Coal No. 1 (?)								1000	-356	3	..	
9	Pana Coal Company	2	NW	NW	15	11N	1E	681	713	-32	8	..	38,156
	C. W. Vanderver	Greenwood								365	7		9,083

All of the mines except that of the Assumption Coal and Mining Company operate coal No. 6. The shaft at Assumption which is the deepest in the State (1004 feet) hoists from beds Nos. 1 and 2.

Coal-bearing Rocks

Sixty logs are available for the study of the coal-bearing beds in Christian County. A large number of these are diamond-drill holes and the resulting information presents a degree of uniformity equalled in but few counties of the State. The prospect holes, however, are so situated that a large area in the south half of the county is left unexplored. The same is true of the extreme northern part of the county but this is near the edge of the basin in which coal No. 6 is developed to commercial thickness and is perhaps not so promising as parts of the south half which will be treated under the subject "Coal No. 6".

The coal-bearing rocks of Christian County vary in thickness from about 800 feet in the western part to more than 900 feet along the eastern border, and are covered by glacial drift which ranges in thickness from 15 feet to almost 150 feet. It must be remembered that the drift was deposited upon a former land surface and that its present thickness depends upon its location, whether on a former hill or in a valley.

In the western part of the county the Carlinville limestone forms the bed rock directly underlying the drift. This limestone is a prominent feature of the logs in that it is persistent and averages from 5 to 10 feet in thickness. In many places it is separated by thin beds of shale into two or more benches. Certain logs show several beds of limestone in a zone about 50 feet wide occupying the general horizon of the Carlinville. The interval between this limestone and coal No. 6 in western and central Christian County is approximately 250 feet, but increases toward the eastern boundary where it is a little more than 300 feet.

In the southeastern corner of the county the New Haven limestone underlies the drift, the dip having carried the Carlinville 300 to 400 feet below the surface. The New Haven limestone is reported to be 20 to 30 feet thick, although it is possible that these figures are somewhat large owing to the local cementation of the basal part of the drift which is likely to be included with the underlying limestone.

The 200-foot interval between the New Haven and Carlinville limestone is occupied mostly by shale. Here and there one or two thin coals are reported, although these are not distinctive features. Black and gray shales also predominate in the 250 to 300-foot interval between the Carlinville limestone and coal No. 6. A persistent bed

of thin coal which has been called No. 8 lies 150 to 180 feet above coal No. 6. Within 50 feet above the last mentioned coal a bed of red or pink shale is commonly noted which, although it rarely reaches a thickness of 10 feet, is so distinctive in color that it is useful in determining the position of the coal beds. This shale is present not only in Christian County, but also over most of southern Illinois. A thin bed of coals, ordinarily less than 1 foot thick, but in one place reported 4 feet 11 inches, commonly lies 30 feet or less above coal No. 6. This coal has been called No. 7.

The usual immediate roof of coal No. 6 is black shale which varies in thickness from less than 1 foot to 10 feet or more. Above this shale, or "slate" as it is called by the miners, is the usual limestone cap rock which ranges in thickness from 1 to more than 20 feet and is almost everywhere present.

Coal No. 6 is persistent and over most of the county is easily recognized. The northern part of the area is near the edge of the basin in which this coal was deposited to its normal thickness. Furthermore, the interval between coals No. 5 and No. 6 decreases towards the north, and the lower coal attains greater thickness, the three conditions combining to render identification of the coals somewhat difficult. Fortunately the character of the beds above coal No. 6 remains constant and serves as an aid to correlation. Coal No. 6 lies at a depth of about 300 feet on the western side of the county, and its eastward dip carries it a little more than 700 feet below the surface along the eastern boundary.

Most of the drill holes have been stopped in the floor of coal No. 6; a few, however, penetrate the entire section of coal-bearing strata. Of the records mentioned the log presented on page 69 is typical. It shows a zone of 250 feet thick consisting of shales, a very small amount of sandstone, and a still smaller amount of limestone. Although 7 coal beds are recorded in this hole, only three are commercially important. A 2-foot 4-inch bed 81 feet below coal No. 6 probably represents coal No. 5. A 2-foot 5-inch bed divided into two equal parts by a 3-inch layer of shale lies 156 feet below coal No. 6 and 100 feet lower, the 2-foot 4-inch bed probably represents coal No. 2. Near Taylorville this horizon shows two beds 12 feet apart, the top bench being 3 feet 11 inches and the lower bench 3 feet 8 inches in thickness. A lenticular bed 2 feet 5 inches thick which may represent coal No. 1 mined at Assumption and in the northwestern part of the Illinois coal field lies 27 feet below the lower bench of No. 2 (?). The other beds are not traceable over any considerable areas; and their thicknesses ranging from a few inches to only slightly more than one foot, class them as commercially unimportant.

Below the coal beds mentioned the strata are more sandy, as is to be expected in the lowermost coal-bearing rocks. The available records show about 200 feet of these sandy shales and sandstones.

At Palmer 220 feet of pink shales, limestone, and sandstone belonging to the Chester group underlie the coal-bearing rocks, and the Chester rests on the massive St. Louis limestone or "Big Lime" of the driller. In the eastern part of the county the Chester beds appear to be considerably thicker, but the only hole that penetrates this group of beds stops at 1335 feet without reaching the "Big Lime".

The following logs show the character of the underlying strata at Taylorville, Assumption, and Pana.

Record of Byrd-Willey drill hole near Taylorville

Hole—No. 13. Location—NW. cor. NW.¼ SE.¼ sec. 13, T. 13 N., R. 2 W.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Clay	14	..	14	..
Sand	8	..	22	..
Clay and rocks	11	..	33	..
Sand, coarse	7	..	40	..
Sand, fine	4	..	44	..
Clay and sand	37	..	81	..
Sand	23	..	104	..
Clay	17	..	121	..
Sand	8	..	129	..
Clay	7	..	136	..
Sand	11	..	147	..
Gravel	2	..	149	..
Clay, sandy	2	..	151	..
Loose boulders	1	6	152	6
Sandstone	9	6	162	..
Shale, blue	3	..	165	..
Shale, soft, light	19	..	184	..
Limestone (Carlinville)	9	6	193	6
Shale, light	1	..	194	6
Shale, black	2	6	197	..
Shale, blue	15	..	212	..
Shale, soft, with hard lumps	7	..	219	..
Limestone and shale mixed	6	..	225	..
Shale, light	3	6	228	6
Limestone	4	..	232	6
Shale, black	1	6	234	..
Shale, light, soft	6	..	240	..
Lime shale	3	6	243	6
Shale, light	9	2	252	8
Coal	..	10	253	6
Shale, light	1	6	255	..

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Shale, sandy	9	..	264	..
Sandstone	9	..	273	..
Shale, sandy	9	..	282	..
Shale, blue	39	2	321	2
Coal	1	3	322	5
Shale, soft	1	7	324	..
Shale, blue	4	..	328	..
Shale, sandy	4	..	332	..
Sandstone, soft, with a few shale streaks	40	..	372	..
Shale, blue	18	..	390	..
Shale, tough, blue	29	..	419	..
Coal	..	3	419	3
Shale, soft	4	9	424	..
Shale, tough, blue	5	..	429	..
Shale, soft	4	..	433	..
Shale, dark	2	..	435	..
Limestone, blue	..	6	435	6
Shale, soft, variegated	10	6	446	..
Shale, dark blue	2	7	448	7
Coal (No. 7)	..	7	449	3
Shale, dark	..	10	450	..
Lime shale	3	..	453	..
Limestone	4	..	457	..
Limestone and shale	2	..	459	..
Sandstone	6	6	465	6
Limestone	1	6	467	..
Shale, black	6	2	473	2
Coal (No. 6)	5	4	478	6
Sulphur band (No. 6)	..	½	478	6½
Coal (No. 6)	..	6	479	½
"Blue band" (No. 6)	..	1¼	479	1¾
Coal (No. 6)	1	7	480	8¾
Sulphur band (No. 6)	..	¼	480	9
Coal (No. 6)	..	4	481	1
Light shale	7	11	489	..
Shale, soft	4	..	493	..
Limestone mixed with shale	7	..	500	..
Shale, soft	4	..	504	..
Shale, light	5	..	509	..
Shale with sand streaks	5	..	514	..
Shale, gray	6	..	520	..
Shale, blue	34	..	554	..
Rock, hard blue	1	..	555	..
Shale, black	6	6	561	6
Limestone, blue	..	11	562	5
Shale, black	..	2	562	7
Coal (No. 5?)	2	4	564	11
Shale, soft	4	1	569	..
Shale with sand streaks	6	..	575	..

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Shale, gray	17	..	592	..
Shale, black	4	..	596	..
Coal	1	..	597	..
Shale, black	..	6	597	6
Sandstone	5	..	602	6
Shale, blue	26	6	629	..
Shale, soft	7	..	636	..
Shale, dark	1	..	637	..
Coal	1	3	638	3
Shale, parting	..	3	638	6
Coal	1	2	639	8
Shale, soft	1	10	641	6
Sandstone	7	..	648	6
Sandy shale	8	6	657	..
Blue shale	8	..	665	..
Shale, black	3	8	668	8
Coal	1	2	669	10
Shale, light, sandy	1	2	671	..
Shale, light	6	..	677	..
Shale, sandy	4	..	681	..
Sandstone	4	6	685	6
Shale, blue	1	..	686	6
Coal, bony	..	4	686	10
Shale, soft	3	2	690	..
Shale, light	2	..	692	..
Shale, dark	2	5	694	5
Coal	..	5	694	10
Shale, dark	1	2	696	..
Shale, soft	5	..	701	..
Limestone	2	9	703	9
Coal	..	7	704	4
Shale, blue	15	2	719	6
Shale, black	2	..	721	6
Shale, gray	4	6	726	..
Shale, blue	2	..	728	..
Shale, dark, blue	9	3	737	3
Coal (No. 2?)	2	4	739	7
Sandstone, soft	17	5	757	..
Shale, light	3	..	760	..
Shale, dark	2	..	762	..
Shale, blue with sandstone streaks	36		798	
Sandstone	34	..	832	..
Sandstone and shale mixed	15	.	847	.
Shale, blue with sand streaks	19	.	866	..
Sandstone and shale mixed	23	.	889	..
Sandstone	4	.	893	.
Shale, dark blue	27	..	919	..
Limestone	31	..	950	..

Record of Byrd & Taylor Hole—No. 8

Location—NE. cor. SE.¼ NE.¼ sec. 35, T. 13 N., R. 1 E.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil	9	..	9	..
Cement sand and gravel	13	..	22	..
Clay, blue gravely	21	..	43	..
Sand	4	..	47	..
Clay, sandy	43	..	90	..
Sand and gravel	25	..	115	..
Shale, soft blue	11	6	126	6
Shale, dark	20	..	150	6
Sandstone	21	6	172	..
Shale, rotten, gray	6	6	178	6
Lime shale with pebbles	2	6	181	..
Limestone	..	7	181	7
Lime shale	8	5	190	..
Limestone (Shoal Creek)	10	9	200	9
Lime shale	..	3	201	..
Shale, dark	2	..	203	..
Shale, tough blue	13	..	216	..
Shale, soft clay	4	..	220	..
Limestone, shaly	3	6	223	6
Shale, sandy	32	..	255	6
Shale, dark	3	..	258	6
Shale, gray	11	6	270	..
Shale, sandy	22	..	292	..
Shale, tough, blue	35	6	327	8
Shale, fossil	1	..	328	6
Coal (No. 8?)	..	6	329	..
Clay shale	3	..	332	..
Lime shale	19	..	354	..
Shale, tough blue	62	5	416	5
Coal	..	3	418	8
Clay shale	4	4	421	..
Lime shale	8	..	429	..
Shale, black	1	..	430	..
Clay shale, soft	4	..	434	..
Shale, soft, red, gray	3	..	437	..
Shale, red	1	..	438	..
Limestone	1	6	439	6
Shale, red and blue	10	..	449	6
Clay shale, soft, rotten	5	6	455	..
Limestone shale mixed	..	6	455	6
Clay shale, soft	..	6	456	..
Clay shale	6	..	462	..
Lime shale	12	..	474	..
Shale, sandy	20	..	494	..
Shale, blue, brown bands	9	..	503	..
Shale, tough, blue, brown band	17	..	520	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Shale, blue, brown bands	13	10	533	10
Coal, shale streaks	..	6	534	4
Coal } No. 6	3	2¼	537	6¼
"Blue band" shale } No. 6	..	¾	537	7
Coal } No. 6	2	3	539	10
Fire clay	1	10	541	8
Shale, gray	7	4	549	..
Shale, black	2	..	551	..
Lime shale	5	6	556	6
Coal, bony	..	3	556	9
Shale, dark	..	3	557	..
Shale, dark blue	1	4	558	4
Limestone	1	8	560	..
Sand and lime mixed	4	6	564	6
Shale, gray	3	..	567	6
Limestone, shaly	8	6	576	..
Shale, sandy	15	..	591	..
Shale, tough, blue	27	..	618	..
Limestone	3	..	621	..
Shale, black	6	8	627	8
Coal	..	6	628	2
Fire clay	1	..	629	2
Limestone	..	6	629	8
Clay shale, soft, rotten	2	2	631	10
Shale, gray	1	..	632	10
Sandstone	1	2	634	..
Shale, sandy	18	..	652	..
Shale, blue	4	..	656	..
Coal	2	..	658	..
Shale, sandy	9	..	667	..
Shale, tough, blue	25	..	692	..
Shale, black	1	6	693	6
Coal	2	2	695	8
Fire clay	..	4	696	..
Shale, gray	6	8	702	8
Shale, dark	2	2	704	10
Coal	..	1	704	11
Shale, blue	..	7	705	6
Coal	..	10	708	4
Shale, gray	5	7	714	..
Sandstone	4	..	718	..
Shale, sandy	7	..	725	..
Shale, blue, brown bands	16	3	741	3
Coal	1	1	742	4
Fire clay	8	..	743	..
Shale, gray	24	..	767	..
Shale, sandy	4	..	771	..
Sandstone	3	5	774	5
Shale	775	8	..	3

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Coal	..	3	775	11
Shale, fossiliferous	1	6	778	5
Coal, bony	..	3	778	8
Coal	1	2	779	10
Shale, blue	1	10	785	..
Coal	..	5	785	5
Shale, dark	3	7	789	..
Shale, sandy	14	8	803	8
Coal }	3	11	807	7
Shale, sandy } No. 2	3	5	811	..
Sandstone }	8	4	819	4
Coal	3	4	819	4
Shale, sandy	9	3	832	8
Coal	..	7	832	10
Sandstone	5	2	838	..
Sandstone shale streaks	21	2	859	2
Coal	2	5	861	7
Dark shale	3	5	865	..
Sandstone shale partings	25	..	890	..
Shale, sandy	19	..	909	..
Shale, tough, blue	19	..	928	..
Shale, rotten, blue	16	..	944	..
Shale, gray	3	..	947	..
Shale, rotten, blue	17	..	964	..

Shaft record of Assumption Coal Mining Co.
Location—NW.¼ SE.¼ sec. 2, T. 12 N., R. 1 E.

Description of Strata		Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Soil		1	6	1	6
Subsoil		1	..	2	6
Clay, yellow		8	..	10	6
Clay, yellow, and sand		8	6	19	..
Gravel, hard, and clay		5	..	24	..
Clay, brown		3	..	27	..
"Soapstone", soft		18	..	45	..
Coal		..	4	45	4
Fire clay		2	..	47	4
Limestone, blue	New Haven limestone	5	..	52	4
Fire clay		1	6	53	10
Clay shale		5	6	59	4
Limestone, gray		6	8	66	..
Limestone, gray, and gray shale		1	..	67	..
Limestone, gray		38	..	105	..
Sand shale		52	4	157	4
Clay shale		14	..	171	4

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Coal	2	6	173	10
Fire clay	6	..	179	10
Sand shale, gray	10	..	189	10
Clay shale	22	8	212	6
Shale, blue	8	..	220	6
Conglomerate lime rock	2	6	223	..
"Slate", black	1	..	224	..
Coal	..	6	224	6
Fire clay	10	6	235	..
Sand rock	40	..	275	..
Sand, porous, (salt water)	14	..	289	..
Limestone	1	6	290	6
Fire clay	10	..	300	6
Limestone (Carlinville or Shoal Creek?)	9	..	309	6
Shale, black	1	6	311	..
Coal	..	6	311	6
Sandstone	4	..	315	6
Limestone and bowlders	21	..	336	6
Sand shale, blue	20	..	356	..
Clay shale	2	..	358	6
Shale, blue	5	..	363	6
Coal and shale	2	..	365	6
Fire clay and bowlders	8	..	373	6
Sandstone	15	..	388	6
Sand rock	50	..	438	6
Shale, black	..	3	438	9
Coal	..	6	439	3
Fire clay	2	..	441	3
Limestone	4	..	445	3
Sandstone	13	9	459	..
Sand shale	52	..	511	..
Fire clay	2	..	513	..
"Slate", black	2	..	515	..
Fire clay, red	12	4	527	4
Lime rock and fire clay	5	..	532	4
Shale, chocolate	6	..	538	4
Shale, blue	25	6	563	10
Shale, black	2	..	565	10
Coal and slate	..	6	566	4
Conglomerate lime and clay	12	..	578	4
Limestone	3	.	581	4
Sandstone	20	..	601	4
Sand shale, blue	23	..	624	4
Sand shale, brown	4	..	628	4
Limestone	1	..	629	4
Coal (No. 6?)	1	8	631	..
Fire clay and bowlders	6	..	637	..
Sandstone	10	..	647	..
Fire clay and rock	7	..	654	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Shale, black	2	..	656	..
Coal	..	2	656	2
Fire clay and rock	10	..	666	2
Limestone, sandy	8	..	674	2
Sandstone and sand shale	8	..	682	2
Sandstone	10	..	692	2
Sand shale, blue	21	..	713	2
Sandstone	1	..	714	2
Shale, blue	32	..	746	2
Fire clay	..	6	746	6
Limestone	..	6	747	2
Fire clay	2	..	749	2
Lime rock and fire clay	5	..	754	2
Limestone	1	..	755	2
Coal	1	..	756	2
Fire clay	4	..	760	2
Sand shale	22	..	782	2
Shale, black	1	6	783	8
Coal	1	6	785	2
Fire clay	..	4	785	6
Sand shale	25	..	810	6
Shale, black	6	..	816	6
Coal	1	..	817	6
Fire clay	3	..	820	6
Limestone	1	..	821	6
Shale, black	5	..	826	6
Coal	1	8	828	2
Fire clay	1	..	829	2
Limestone	1	4	830	6
Sand shale	18	..	848	6
Lime rock, sandy, and small bowlders	1	6	850	..
Hard fire clay and bowlders	15	..	865	..
Sandstone	16	4	881	4
Sand shale	18	2	899	6
Shale, black	1	..	900	6
Coal	..	2	900	8
Fire clay	2	..	902	8
Limestone	5	..	907	8
Sand shale, blue	7	..	914	8
Shale, black	1	..	915	8
Coal	..	5	916	1
Fire clay	5	6	921	7
Fire clay and bowlders	7	6	929	1
Sand shale	25	8	954	9
Shale, black	5	..	959	9
Coal[2]	2	2	961	11
Fire clay	..	3	962	2
Lime and sandstone	1	6	963	8

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sand shale, dark	14	..	977	8
Conglomerated rock	1	6	979	2
Coal[9]	3	6	982	8

Geologic Structure

Christian County is on the western side of the Illinois coal basin. Throughout the county, so far as known, the geologic structure consists of a uniform dip towards the southeast into the lower part of the basin. Near the county line west of Kincaid coal No. 6 lies 280 feet above sea level; whereas south of Pana in the southeast corner of the county this bed is 70 feet below the sea or 720 feet beneath the surface, conditions which show an average dip of 11 feet per mile.

Unfortunately a large part of the south half of the county is unexplored by the drill and the structure is not known. In view of the regularity displayed by the beds in the central part of the county, and along the southern border, it is believed that no pronounced irregularities in the dip exist anywhere in the county. Minor folds are known, as in sec. 19, T. 13 N., R. 2 W., from where the coal dips to the north and south. A small arching of the beds is shown by the drill holes located south of the county line in secs. 2 and 3, T. 10 N., R. 2 W. At the SW. cor. sec. 35, T. 11 N., R. 2 W. the coal is 76 feet above sea level, or 35 feet higher than it is 1 mile north or south.

Coal No. 6

DISTRIBUTION AND THICKNESS

Of the coal produced in Christian County, 95 per cent is mined from coal No. 6. The remainder comes from two beds in the lower part of the "Coal Measures" at Assumption which may represent coals No. 1 and No. 2, or possibly the upper and lower benches of coal No. 2 or No. 1. Definite correlations have not been made.

Coal No. 6 is best known in the vicinity of the present mines at Taylorville, Kincaid, Edinburg, and Pana. Diamond drill holes have proved the presence of the bed north of the south line of T. 13 N. and south of the north side of T. 14 N. It is commercially developed at Pana and the drill has shown coal No. 6 to underlie at least the south half of the two townships west of Pana.

Doubtless the area in which the coal is thin or absent in Montgomery, Bond, and Clinton counties, extends northeast at least into the

[9]Definite correlations of these coals have not been made. They probably represent coals No. 1 and No. 2, but they may be the upper and lower benches of either No. 1 or No. 2.

southwestern part of Christian County. One boundary of this area is fairly definite in the southern half of T. 11 N., R. 2 W., where a drill hole in the SE. cor. sec. 31, and another a quarter of a mile south failed to penetrate any coal at the horizon of coal No. 6. At Palmer, 8 miles northwest, the churn drill penetrated no coal. The area between has not been tested, but it is believed that it will prove to be unfavorable so far as coal No. 6 is concerned. The general direction of the barren area is northeast-southwest, but its shape in Christian County is extremely uncertain, owing to the scarcity of drill records in the possible "pockety" area. At the Assumption mine, sec. 2, T. 12 N., R. 1 E., only 1 foot 8 inches of coal is found at the horizon of coal No. 6. Absence of this coal is noted in a hole at Dunkel 3 miles south of Assumption.

At Pana 6 miles further south, the coal attains a thickness of 8 feet; therefore the south boundary of the barren area is located between Dunkel and Pana. Normal coal is found 6 miles west of Assumption and has been traced north from this point. Whether or not the area of thin coal No. 6 is in the vicinity of Assumption is part of the area referred to above is not determined, but it is believed that the two are connected. Even if this is true, there seems no doubt that a considerable body of good coal exists outside the borders of the area. In Christian County T. 12 N., Rs. 3 and 4 W. offers favorable territory for the drill. North and west of this area coal No. 6 appears to be developed to its normal thickness and it is believed that by drilling first in the northwest and later towards the southeast, the possible "spotty" territory, a considerable acreage of commercial coal may be found.

The extreme northern part of the county in Tps. 15 and 16 N. Rs. 1, 2, and 3 W. has not been explored by the drill. This is near the line north of which No. 6 is too thin to be commercial. The border is not a definite line, but rather a zone several miles in width, in which coal No. 6 is developed to normal thickness in one place and deposited nearby to a thickness of but a foot or two. At Mechanicsburg a few miles north of the county line where coal No. 6 was mined formerly, the coal was about 6 feet thick at the shaft, but thinned to 2 inches in a distance of 800 feet north. At Chatham, 8 miles southwest of Springfield, coal No. 6 is between 5 and 6 feet thick. Future prospecting will probably show that considerable acreage of coal No. 6 exists in Tps. 15 and 16 N., Christian County, but drill holes must be placed closer to each other than is customary in the Illinois fields, in order to secure correct knowledge of the area.

In T. 13 N., R. 1 E., 1, 2, and 3 W. coal No. 6 averages 7 feet in 21 drill holes and mines distributed over the area. The tier of townships

to the north is underlain by coal No. 6 ranging from 4 feet 3 inches to 7 feet 8 inches, the average being 5 feet 11 inches in 13 measurements. At Pana in the southeast corner of the county the coal varies in thickness from 7 to 8 feet; and the same figures represent its thickness in the drill holes indicated on the map in T. 11 N., R. 1 and 2 W.

Sections measured at the face in 7 mines now operating or formerly active show coal No. 6 including all bands to vary in thickness from 80 to 109 inches.

PHYSICAL CHARACTER OF COAL NO. 6

The so-called "blue band" is the most persistent of the impurities in the bed and occupies a position 10 to 20 inches above the floor. This layer is variable in thickness and character. It is generally not less than 1 inch thick, and in places a double band occurs at this horizon, each part ranging from ½ inch to 3 inches, the two being separated by about 2 inches of coal.

Pyrite bands are present especially in the middle bench. They are in most places less than 1 inch thick, and can be excluded by reasonable care in mining. This is not true, of course, with the sulphides which are disseminated throughout the coal mass.

As a whole, the bed shows a dull lustre. At Taylorville the bottom bench contains the hardest, brightest coal and breaks up into cubical blocks. It is customary to mine the entire bed and to make use of the shale and rock roof rather than to leave the top coal as is done in parts of southern Illinois. Figure 9 shows graphically the characteristics of coal No. 6 in Christian County.

The bed is not affected by any major irregularities in the mines thus far exploited. A few small faults having a throw of only a foot or two were noted at Stonington, but as a rule conditions are uniform.

ROOF AND FLOOR

The regular roof of coal No. 6 in Christian County is a black shale overlain by a limestone which ranges in thickness from 1 foot to more than 20 feet. The black, laminated shale below the limestone is reported as thick as 8 feet in the mines of the county. In places the shale is absent, and the limestone immediately overlies the coal and forms an excellent roof which requires much less timbering than does the more easily broken shale. Here and there 3 or 4 inches of loosely consolidated, lighter-colored shale, called "clod" by the miner, rests on the coal, and must be "drawn" when the coal is removed.

The floor is generally clay of variable thickness. From 4 to 6 feet of this material is not uncommon and more is reported in some of the mines. Its thickness is somewhat uncertain owing to the few

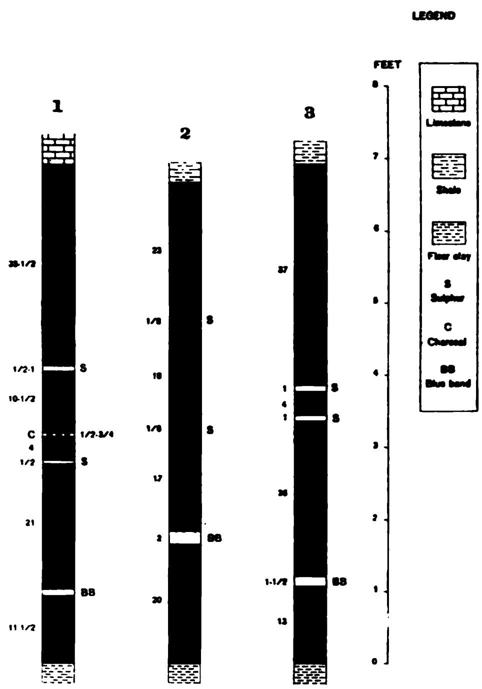

Fig. 9.—Graphic sections of coal No. 6 from measurements made in mines of Christian County.

1. Stonington Coal Co., Stonington. Room 4, 4th NW. off main entry.
2. C. W. Vanderver, Edinburg. 1st S. off main west entry.
3. Penwell Coal Co., No. 1, Pana. Room 1, straight N., main east entry.

places in which it is penetrated in mining. It is commonly underlain by dark-gray or light-colored shales, and in places thin limestones lie a short distance below the clay, although they are more or less impure and can not be traced throughout the county.

In one of the mines at Pana, the floor squeezes where the roof is hardest, and as a result the lower part of the coal bed is fractured.

Coals below No. 6

The coals below No. 6 are lenticular and hence less easily traceable. Moreover, the interval between the beds, especially between coals No. 5 and 6, varies considerably in short distances, thus adding to the difficulty of correlation. For example, the interval between coal No. 6 and the next lower important coal varies from 20 feet in the vicinity of sec. 34, T. 14 N., R. 2 W. to about 75 feet in sec. 13, T. 13 N., R. 2 W. The lower bed ranges in thickness from 1 foot to 5 feet and averages 3½ feet in 8 diamond drill holes in the townships mentioned.

It is probable that it should be called coal No. 5 since the larger interval is not uncommon in the counties south of Christian, and the smaller one is well known to the north as in the mine at Mechanicsburg. Even at Springfield the average interval between coals No. 5 and No. 6 is but 39 feet. This bed tends to become thicker towards the north, and in secs. 13, 22, 32, and 34, T. 14 N., R. 2 W. coals No. 5 and No. 6 are of about equal importance. In a majority of the holes the roof of coal No. 5 is composed of a few feet of black shale capped by a thin limestone, this succession of beds being the normal one in the Springfield district where coal No. 5 is mined. Near Edinburg and Sharps the cap rock is absent.

Only a few holes have been drilled through the lowest bed of the "Coal Measures", and it is possible to draw only general conclusions regarding the distribution of the earlier coals. Three main horizons appear to exist below coal No. 5. Owing to the lenticular nature of the coal it is not believed that all three horizons contain commercial coals throughout the county. In places a bed of coal separated into 2 benches by shale varying from a few inches to 6 or 8 feet in thickness, is reported to lie 70 feet below coal No. 5. The aggregate thickness of the coal is reported to reach as much as 5 feet, although neither bench is known to be more than 2 feet 10 inches.

About 250 feet below coal No. 6 is an horizon which should be tested in any attempt to explore the coal resources of the county. This coal occupies the general position of coal No. 2 and may have been deposited contemporaneously with the Murphysboro bed. Some coal generally exists at this horizon but the determination of its thickness and character must be left to the drill. In places it exists as a single bed; whereas in others it is separated into two benches by a variable amount of shale or sandstone. A combined thickness of 6 feet is not unknown.

About 36 feet below the lower bench of the coal mentioned above, there is developed in places a bed known as coal No. 1, probably equivalent to at least one of the beds mined at Assumption. In sec. 35, T. 13 N., R. 1 W. a 2-foot 5-inch coal lies 318 feet below coal No. 6 and probably corresponds in position to the upper bed at Assumption. Three typical logs are graphically compared in figure 10.

The lenticular character of the coal beds in the lower part of the "Coal Measures" renders predictions unsafe, but the existence of coals that may prove to be commercial, as at Assumption, is highly probable. With this in mind it seems reasonable to suggest that in drilling, most of the holes should be extended at least through the horizon of coal No. 5 which in most places is not more than 70 feet below coal No. 6.

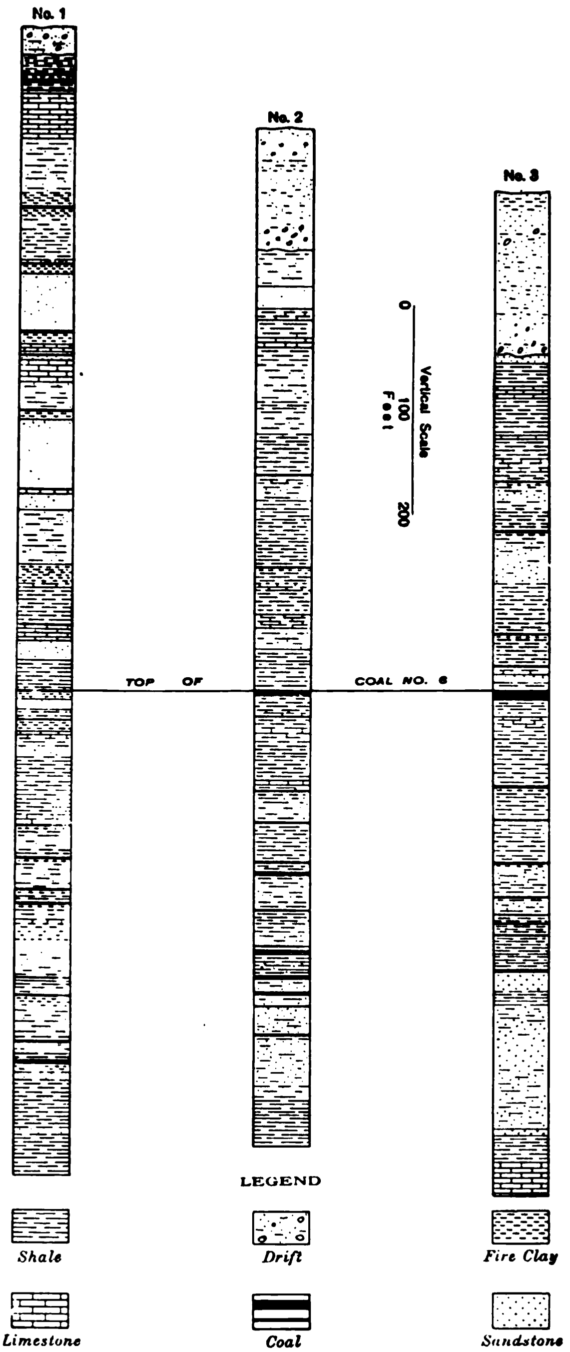

FIG. 10.—Graphic sections of drill holes in Christian County.

1. Shaft at Assumption.
2. Byrd & Taylor, hole No. 8 in SE.¼ NE.¼ sec. 35, T. 13 N., R. 1 W.
3. Byrd & Taylor, hole No. 13 in NW.¼ SE.¼ sec. 13, T. 13 N., R. 1 W.

A few holes should be continued from 250 to 300 feet below coal No. 6 in order to test all of the possibilities of the area.

Coal No. 7

About 30 feet above coal No. 6 is a bed which rarely attains a thickness of more than a few inches. Earlier in this report it has been designated as coal No. 7. Diamond-drill records in the southwestern part of T. 14 N., R. 2 W. seem to indicate a somewhat abnormal development of this bed to a thickness which, if affecting a considerable area, might lend to it commercial value. Records show thicknesses ranging from 3 feet to 4 feet 11 inches, but it is believed that such a development of coal No. 7 is restricted to a small area and is not to be expected outside.

FAYETTE COUNTY

Production

No coal production is reported from Fayette County. In 1874 a shaft at Vandalia was sunk to a depth of 377 feet, and from the bottom of the shaft a hole was drilled to a depth of 574 feet without finding a workable coal bed. From data at hand, it appears that the hole was continued just far enough to reach the horizon of coal No. 6, and that this bed is absent at this point.

A few of the thin coals in the upper "Coal Measures" outcrop at several places in the county east of a general north-south line through the middle of R. 2 E. Here and there one of these lenticular beds attains a thickness of 2 feet, and formerly coal was mined for local consumption at a number of places in the county.[a]

Coal No. 6 is mined north of the county at Pana, south at Centralia, and west in Montgomery County. Prospecting has been extended into Fayette County eastward, and doubtless shafts will be sunk there in the future, especially after the more easily accessible coal has been extracted.

Coal-bearing Rocks

The coal-bearing beds of Fayette County have been explored by about 20 drill holes and by the shaft mentioned above. About half of the holes were discontinued in the fire clay underlying coal No. 6, a few penetrate the lower coals, and two put down in search of petroleum reach depths of 2825 and 2960 feet. All except 2 of the holes of which the records are available for study, are located in the two west tiers of townships. The well of the Producers Oil Company

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[a]Ill. Geol. Survey, vol. 6, p. 143, 1875.

in the NE. ¼ NW. ¼ sec. 22, T. 9 N., R. 1 W. shows 1140 feet of coal-bearing rocks. Their nature is best known above coal No. 6 which lies from 490 feet beneath the surface in sec. 4, T. 6 N., R. 1 W. to about 730 feet near Farina in T. 5 N., R. 5 W.

These beds are overlain by the glacial drift which varies in thickness from 30 or 40 feet to about 150 feet. Where erosion prior to the deposition of the drift did not cut down too deeply, a thick limestone is found a short distance below the drift. This limestone occupies the position of the New Haven which has been described previously. Where the limestone is present, it forms in most places a conspicuous bed which in places attains a thickness of 25 feet, although its average is considerably less. From 200 to 250 feet below the New Haven is the Carlinville limestone which can be recognized in most of the holes.

A few thin coals lie between the two limestones mentioned but they are lenticular and unimportant. Shales and a few minor beds of sandstone constitute the interval. Between the Carlinville lime and coal No. 6 which lies about 310 feet below, the records show a larger amount of sandstone than is common in this part of Illinois. Several logs show a thick bed of sandstone including beds of shales or limestones about half way between the Carlinville limestone and coal No. 6.

The thin bed of coal which is generally found about 180 feet above coal No. 6 is not reported in the holes of Fayette County. Coal No. 7 which is shown in most of the holes lies from 20 to 30 feet above No. 6 and appears to be thicker here than in the counties to the west. Half of the logs record this bed and show a thickness ranging from a few inches to 2 feet 7 inches, the average being 2 feet where the bed is present.

Most of the records show the usual limestone cap rock above coal No. 6 with a thin intervening bed of black shale, but holes in sec. 22, T. 9 N., R. 1 W.; sec. 15, T. 6 N., R. 1 E.; and sec. 24, T. 6 N., R. 2 E., show only a shale roof, the limestone probably having been eroded subsequent to deposition.

Nine churn-drill holes penetrate the lower part of the "Coal Measures", but the logs are unsatisfactory. As much as 550 feet of coal-bearing rocks are known below coal No. 6, but aside from the fact that more sandy beds exist near the base and a few coal beds are noted, little definite information is available.

The following logs are typical of the coal-bearing strata in Fayette County.

Drill record of E. S. Peabody hole

Location—NE.¼ SW.¼ sec. 16, T. 8 N., R. 1 E.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil	1	..	1	..
Clay	11	..	12	..
"Hardpan"	15	..	27	..
Sand	14	..	41	..
Clay, yellow	12	..	53	..
Bowlders	1	..	54	..
Clay and gravel	4	..	58	..
Clay, yellow	5	..	63	..
Sand	3	..	66	..
Clay	9	..	75	..
Clay and gravel	9	..	84	..
Limestone, broken	14	..	98	..
Limestone, hard, blue (New Haven)	9	..	107	..
Sand shale	3	..	110	..
Sandstone	2	..	112	..
Sand shale	7	..	119	..
Sandstone	1	6	120	6
Sand shale	21	6	142	..
Sandstone	1	..	143	..
Sand shale	9	..	152	..
Sandstone	2	..	154	..
Sand shale	12	..	166	..
Shale, soapy, lime spots	4	..	170	..
Shale, dark, soapy	1	6	171	6
Coal	..	6	172	..
Fire clay, soft	6	6	178	6
Sandy shale	22	6	201	..
Shale, dark, soapy	28	6	229	6
Shale, dark, limy	1	6	231	.
"Slate", black	2	..	233	..
Coal	1	..	234	..
Fire clay	6	..	240	..
Shale, blue	2	..	242	..
Sand shale, lime spots	11	..	253	..
Limestone	..	8	253	8
Sand shale	6	4	260	..
Shale, soapy	20	..	280	..
Sand shale, lime band	15	..	295	..
Shale, soapy	10	..	305	..
Lime shale	3	6	308	6
Shale, soapy	1	2	309	8
Coal	..	4	310	..
Fire clay	3	9	313	..
Shale, soapy	13	3	327	..
Lime shale	2	..	329	..
Sand shale	3	..	332	..
Sandy shale	21	..	353	..

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Limestone (Shoal Creek?)	5	..	358	..
Shale, tough, blue	1	..	359	..
"Slate", black	4	6	363	6
Chert	..	6	364	..
Sand shale	13	4	377	4
Shale, soapy	6	..	383	4
Shale, soapy, hard sand partings	4	6	387	10
Sand shale, hard	8	8	396	6
Shale, tough, dark	17	6	414	..
Shale and bands, soapy	6	7	420	7
Sand shale	9	5	430	..
Shale, dark, sand bands	11	..	441	..
Shale, dark	6	..	447	..
Sandstone, hard	3	..	450	..
Sand shale	9	..	459	..
Sandstone, hard	2	..	461	..
Sand shale	7	..	468	..
Sand shale, hard	26	..	494	..
Sandstone	1	..	495	..
Sand shale, hard	9	..	504	..
Sand shale, hard	24	..	528	..
Sandstone	1	..	529	..
Sand shale	2	..	531	..
Sandstone	49	..	580	..
Lime shale, sandy	1	6	581	6
Shale, tough, dark	2	..	583	6
Shale, sandy	10	6	594	..
Shale, tough, dark	25	6	619	6
Shale, red	1	6	621	..
Sand shale, hard	5	..	626	..
Shale, red	2	..	628	..
Shale, dark	3	..	631	..
Lime shale, hard, sandy	9	6	640	6
Shale, dark, tough	2	5	643	..
Shale, dark	1	..	644	..
Chert	..	10	644	10
Shale, dark, tough	7	2	652	..
Shale, soapy	3	..	655	..
Shale, soft, black	2	6	657	6
Limestone, hard	..	6	658	..
Shale, soft, black	..	6	658	6
Lime shale, hard	1	6	660	..
Shale, dark	1	..	661	..
Shale, soapy	4	11	665	11
Coal	..	8	666	7
Slate	..	3	666	10
Coal	..	2	667	..
Slate, limy	..	5	667	5
Slate, black	2	7	670	..

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Coal (No. 6)	6	7	676	7
Sandstone	6	11	683	6
Sandstone shale partings	4	6	688	..
Shale, soapy	5	..	• 693	..
Sandstone, limy	3	10	696	10
Slate, black	1	2	698	..
Coal (No. 5?)	4	..	702	..
Fire clay, soft	2	..	704	..
Shale, hard, blue	2	..	706	..

Geologic Structure

A small number of holes in the county renders a determination of detailed structure impossible. The strike of the beds in the western part of the county is almost north-south and the dip is eastward into the Illinois coal basin. The only holes in the eastern part of the county, one in sec. 24, T. 6 N., R. 2 E., and the other in sec. 32, T. 5 N., R. 4 E. show coal No. 6 at 40 and 140 feet below sea level, respectively. In the latter hole at Farina the coal is 130 feet higher than at Kinmundy, six miles southwest. It is possible that the deepest part of the basin is not regular in shape, but that a syncline having a north-south axis connecting with the main basin at the south extends through the eastern part of Marion County and into the southern part of Fayette County. That this syncline does not extend through Fayette County is shown by the position of coal No. 6 in sec. 24, T. 6 N., R. 2 E., where it stands higher than at Vandalia, 10 miles west.

Coal No. 6

DISTRIBUTION AND THICKNESS

Coal No. 6, which ranges in depth from 490 feet in sec. 4, T. 6 N., R. 1 W. to 720 feet at Farina in the southeast corner of the county, is commercially the most important bed. Its presence has been demonstrated throughout the greater part of the western half of the county, although its thickness is not in all places sufficient to encourage mining. The northwest quarter of the county has been better explored by the drill than have the remaining areas, and in this quarter, comprising Tps. 7, 8, and 9 N., Rs. 1 E. and 1 W., coal No. 6 averages 6½ feet in thickness. In the vicinity of Vandalia this coal appears to be thin or absent. To the north in sec. 16, T. 7 N., R. 1 E. no coal is reported at this horizon, and it is possible that a considerable area in this part of the county will prove to be barren of coal No. 6 in commercial

thickness, but any attempt to outline such an area with the meagre information available would be futile.

A churn-drill hole in sec. 24, T. 6 N., R. 2 E. 10 miles east of Vandalia reports 7 feet of coal No. 6; at Farina in the southeast corner of the county the same bed is said to be 6 feet thick. The fact that in the southeastern part of Bond County and in the northern part of Marion County the coal is below normal thickness, lends support to the belief that this bed will show similar characteristics in southern and southwestern Fayette County, although the drill alone will determine the facts.

ROOF AND FLOOR

Knowledge of the characteristics of roof and floor is limited to drillings and is necessarily unsatisfactory in comparison with examinations in the mine. A limestone cap rock is present over most of the prospected area, but in sec. 22, T. 9 N., R. 1 W.; sec. 15, T. 6 N., R. 1 E.; and in sec. 24, T. 6 N., R. 2 E. only shale is found over the coal, the limestone probably having been eroded after deposition. In places the cap rock is reported to lie in contact with the coal, but generally a few feet of black shale intervene as is usual in the Belleville district. In practically every hole the material under the coal is reported as clay or shale.

COALS BELOW NO. 6

The coals below coal No. 6 in part of Fayette County appear to be extremely lenticular. The diamond-drill hole in NE. ¼ SW. ¼ sec. 16, T. 8 N., R. 1 E. shows a 4-foot coal 28 feet below the top of coal No. 6. The interval here appears to be too small for No. 5, but such a figure would not be unusual farther north in Christian County. No coal is found in a similar position in any of the other Fayette County logs. A 1-foot bed is noted in sec. 15, T. 6 N., R. 1 E. 85 feet below coal No. 6, and 45 feet lower is another bed said to be 5 feet thick. A hole drilled in the same section by another company shows the same coal horizons, but the log reverses the thicknesses of the two lower coals, and it is thought that the records are not reliable as to the coal. Three records show coal ranging in thickness from 1 to 5 feet about 250 feet below coal No. 6; whereas other holes passing through the same horizon fail to penetrate any coal. The data available do not permit a safe conjecture as to the existence of a coal below No. 6 which might be commercially developed in the future.

MACOUPIN COUNTY

Production and Mines

Production in tons, year ended June 30, 1913....	5,208,682
Average annual production 1908 to 1913........	4,504,632
Total production 1881 to 1913.................	73,459,119

The 15 mines of Macoupin County produced 8.6 per cent of the total output for the State in 1913. Four of these mines: Superior Coal Company Nos. 1, 2, and 3 at Gillespie, and Consolidated Coal Company No. 14 at Staunton, averaged more than 3000 tons per day. Table 6 is a list of the shipping mines and data concerning them. The production is for the year ended June 30, 1913.

Coal-bearing Rocks

The character of the coal-bearing beds is best known in the eastern half of the area where about 100 holes and shafts have been sunk at least as deep as coal No. 6, which lies 300 to 400 feet below the surface in this part of the county. The beds rise gently towards the west, and coal No. 6 reaches the surface near the western border. It outcrops and was formerly mined in the bluffs of Hodges Creek in sec. 29, T. 10 N., R. 9 W. Coal No. 5, about 50 feet below coal No. 6, is said to be visible at this place during low water. No accurate measurements have been made, but its thickness is reported to be about 2 feet.

The "Coal Measures" are thinnest along the western boundary of the county, where about 300 feet of strata overlie the Mississippian limestones. From 5 to 10 miles farther west in Greene and Jersey counties, the lowermost coal-bearing rocks appear at the surface. At Carlinville more than 500 feet of these beds are known, and at the extreme eastern side of the county they attain a thickness of about 700 feet.

The surface deposits range in thickness from 20 to 200 feet or more showing a former relief even greater than that of the present.

The Carlinville limestone 220 to 250 feet above Coal No. 6 reaches its western limit a short distance west of the town of the same name, and its outcrop can be traced southeast toward Staunton and into the southern counties. This limestone outcrops in many of the streams near Carlinville and may be recognized without difficulty. It forms the bed rock over an extensive area in this part of the State and lies immediately under the glacial drift. Although its average thickness is but 9 feet, its persistency lends to it considerable usefulness in the proper correlation of beds. In the eastern part of the county this limestone is found as far as 150 feet below the surface.

TABLE 6.—*List of shipping mines, Macoupin County, 1913*

Map No.	Company	Mine	Location ¼	Location ¼	Location Sec.	Location T. N.	Location R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	Average thickness In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Superior Coal Co.	3	NW	NW	36	8	7	641	346	295	7	..	837,834
2	Superior Coal Co.	2	NW	SW	6	7	6	620	317	303	7	6	828,288
3	Superior Coal Co.	1	SE	NW	29	8	6	630	340	290	7	6	681,852
4	Consolidated Coal Co.	14	..	NE	30	7	6	605	285	320	7	..	651,229
5	Consolidated Coal Co.	15	north	cen.	9	7	6	645	362	283	7	..	460,201
6	Royal Colliery Co.	1	SW	SW	8	12	6	673	314	359	6	6	395,652
7	Girard Colliery Co.	5	SE	SE	32	12	6	676	345	331	7		353,002
8	Madison Coal Corporation	..	..	NW	1	7	6	680	417	263	8	..	279,290
9	Glenridge Coal Co.	1	..	NE	9	12	6	674	320	354	7	..	242,122
10	Vivian Collieries Co.	..	SW	SW	5	11	6	674	352	322	6	6	209,213
11	Consolidated Coal Co.	8	..	SW	11	7	6	680	393	287	7	9	185,541
12	Carlinville Coal Co.	..	..	NW	28	10	7	627	258	369	7	..	77,790

A few thin coals lie between the Carlinville limestone and coal No. 6 below, but they do not appear to be so persistent as in Christian County. However, the discovery of the persistent nature in the latter area may be due to the use of the diamond drill. A few inches of coal No. 7 is generally found as usual about 30 feet above coal No. 6. In many places it has a limestone roof whose thickness is regularly less than that of coal No. 6. A few logs show a 2-foot coal about 150 feet above coal No. 6. This bed is probably to be correlated with coal No. 8 which has been described in other counties, but its lack of persistency in Macoupin County renders it almost useless in correlation.

Coal No. 6 and its limestone cap rock are the most widely developed in the county. In but few holes is one or the other absent. In the Griffell well, NW. ¼ SE. ¼ sec. 15, T. 9 N., R. 7 W., the absence of both is due to pre-glacial erosion which extended to a depth of 235 feet.

Underlying coal No. 6 are 300 to 500 feet of coal-bearing rocks, but little is known of their nature except that they consist largely of shales, a few sandy beds especially in the lower parts, and lenticular beds of coal. The deeper holes were drilled in search of oil, and little attention was given to the lower coals. Coal No. 5 was noted by Worthen in a few outcrops along the western side of the county where it is 30 to 40 feet below coal No. 6. In the logs available for study its absence is conspicuous. Scattered records show a thin coal from 80 to 100 feet below coal No. 6, which may represent coal No. 5, but the interval appears to be too large for such a correlation. From 200 to 250 feet below coal No. 6 in the general position of coal No. 2, a few records show from 3 to 4 feet of coal. This, the lowest bed in the county, is but a short distance above the thick Mississippian limestones upon which the "Coal Measures" lie.

The following logs represent typical borings in various parts of the county:

Well record submitted by Thos. Rinaker
Farm—Dews
Location—NE. cor. NW.¼ NW.¼ sec. 2, T. 9 N., R. 9 W.

Description of Strata	Thickness *Feet*	Depth *Feet*
Pennsylvanian Strata		
Clay, yellow	65	65
Mud, white	41	106
Quick sand and gravel	4	110
Mud, yellow	10	120
Lime (good flow fresh water)	8	128
"Slate" white	22	150

Description of Strata	Thickness Feet	Depth Feet
Coal (No. 6)	4	154
"Slate", white	11	165
"Slate", brown	10	175
Mud, white	35	210
Sand, black (?)	20	230
"Slate", white	15	245
"Slate", brown	15	260
Coal	4	264
Slate", brown	4	268
Mud, white	5	273
"Slate", white	7	280
Sand, broken, dark	20	300
Sand, white	10	310
Mississippian strata (upper beds)—		
Lime, sandy	10	320
Mud, white	10	330
Limestone (brackish water)	00	530
"Slate", black	10	540
Lime, dark	10½	550½

Well record of Haake well, Impromptu Exploration Co.
Location—SW.¼ NW.¼ sec. 17, T. 9 N., R. 7 W.

Description of Strata	Thickness Feet	Depth Feet
Top soil	30	30
Quick sand and gravel	25	55
Blue gumbo clay	25	80
"Slate", white	50	130
"Slate", black	5	135
Lime, white	3	138
"Slate", white	12	150
Lime, white	5	155
"Slate", white	5	160
Limestone and slate	5	165
"Slate", black	2	167
Limestone, gray	1	168
"Slate", white	4	172
Coal (No. 6)	5	177
"Slate", white	73	250
"Shale", brown	20	270
"Slate", white	10	280
Shale, brown	5	285
"Slate", white	15	300
"Slate", black	13	313
"Slate", white	6	319
Limestone shells	6	325
"Slate", white	21	346
"Slate", black	10	356
"Slate", white	12	368

Description of Strata—	Thickness *Feet*	Depth *Feet*
Shale, black, and coal	2	370
"Slate", white	5	375
Shale, black	12	387
"Slate", black (show of oil 392 to 410 feet)	2	389
Sand (oil 417)	24	413
Salt water (421)	37	450

Record of F. S. Peabody hole

Farm and hole—Davis No. 7

Location—NW.¼ NW.¼ sec. 11, T. 10 N. R. 6 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil	2	..	2	..
Clay, yellow	14	..	16	..
"Hardpan"	2	..	18	..
Clay, yellow	20	..	38	..
"Hardpan" and gravel	10	..	48	..
Clay, blue	26	..	74	..
Gravel	3	..	77	..
Limestone, broken (Carlinville)	11	6	88	6
"Slate", black	8	6	97	..
Shale, soft, soapy	9	..	106	..
Limestone	1	6	107	6
Lime shale	1	6	109	..
Shale, soft, soapy	9	6	118	6
Lime shale	2	..	120	6
Slate, black	2	6	123	..
Coal	..	8	123	8
Fire clay	6	4	129	..
Lime shale	7	..	136	..
Sand shale, hard bands	9	..	145	..
Shale, tough, lime bands	11	..	156	..
Limestone	4	..	160	..
Slate, black	..	6	160	6
Lime shale	1	..	161	6
Sandstone	1	6	163	..
Shale, gray	26	10	189	10
Coal	..	9	190	7
Fire clay	2	5	193	..
Lime shale	6	..	199	..
Sand shale	41	..	240	..
Shale, tough, gray	14	..	254	..
Slate, hard, gray	11	..	265	..
Shale, soft, dark	4		269	..
Clay shale, soft	3	..	272	..
Sand shale	6		278	
Sand shale, hard	19	6	297	6
Slate, black	2	3	299	9

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Coal	1	..	300	9
Fire clay	3	3	304	..
Sand shale	8	..	312	..
Shale, soft, blue	3	..	315	..
Limestone	6	..	321	..
Shale, soft	1	..	322	..
Clay shale	1	..	323	..
Slate, black	2	3	325	3
Coal	..	3	325	6
Clay shale	7	4	332	10
Limestone	5	10	338	8
Clay shale	1	..	339	8
Limestone	8	10	348	6
Slate, black	1	..	349	6
Coal (No. 6)	5	8	355	2
Fire clay	..	10	356	..

Geologic Structure

The lowest beds that outcrop in Macoupin County are near coal No. 6, which reaches the surface in the extreme western part at an altitude of about 600 feet above sea level. The glacial drift covers most of the surface and the outcrops are confined to the stream channels that have been cut into the bed rock.

All the beds dip eastward at the rate of about 14 feet per mile. Data are too meagre in the western half of the county to permit the drawing of detailed structure contours. In the eastern half of the area, although the general dip is eastward in places slight modifications and even reversals of this dip have been noted. In secs. 7 and 8, T. 9 N., R. 7 W. the beds occupy the position of a small dome, the center of the arch being about 50 feet higher than the surrounding areas. This structural feature has proved to be of some economic importance, because of its effect on the accumulation of oil and gas. For details regarding the Carlinville dome, the reader is referred to Extracts from Bulletin 20.[4] The 50-foot contour interval used on the large map in the present report, is too large to show properly the shape of the dome.

The doming of the strata two miles northwest of Staunton is another variation in the general eastward dip. Inside of the closed contour shown on the map the coal is from 20 to 30 feet higher than in the surrounding area. This Staunton dome has not been tested by holes sufficiently deep to reach the Pottsville beds which produce some oil at Carlinville.

[4]Kay, Fred H., The Carlinville Oil and Gas Field: Ill. State Geol. Survey, Extracts Bull. 20, p. 38, 1912.

No large faults are known in the county. Here and there in the mines a small slip is noted, but the beds appear to be free from troublesome displacements.

Coal No. 6

DISTRIBUTION AND THICKNESS

Coal No. 6 underlies practically the entire county. A small area in the northwest is probably beyond the outcrop, and it is also likely that in the shallow area in the western half of the county the coal has been eroded by streams which were active on the old surface before glacial times. A hole in sec. 1, T. 9 N., R. 9 W., probably passed through such an ancient channel; whereas another hole one and one quarter miles northwest of the former shows coal No. 6 although it is somewhat thinner than normal. Beside the absence of the coal due to erosion immediately preceding glacial times, other irregularities are known to be the result of channels which existed during, or shortly after, coal deposition. The Griffell well mentioned above is an example of the former type in which glacial drift extends downward below the horizon of coal No. 6; whereas other wells showing no coal contain a considerable thickness of sedimentary rocks above the position of the coal. This is true especially in the vicinity of the Carlinville oil field. In this general locality a drainage channel probably existed shortly after the coal was deposited. The V. Hall well No. 5 and McClure wells Nos. 1, 2, 3, and 6 in the central part of sec. 8, T. 9 N., R. 7 W., show no coal; whereas V. Hall well No. 3, SW. ¼ SE. ¼ NW. ¼ sec. 8 penetrates 5 feet of coal No. 6. From the information at hand it is not possible to outline the course or extent of the ancient channels. To the north and south uniformly thick coal is found, although but little prospecting has been done between the area underlain by thin coal southwest of Carlinville and the similar area in western Montgomery County to the east. It is possible that the two are connected and that on the map the western border of the barren area in Montgomery County should by the westward extension of the line be made irregular to include the area described in Macoupin County.

In the eastern half of the county excluding the area mentioned above the coal averages 7 feet in thickness, the maximum being about 9 feet. At Bunker Hill, sec. 14, T. 7 N., R. 8 W., and at Chesterfield, sec. 2, T. 9 N., R. 9 W., the same coal averages 5 to 5½ feet and the few prospect holes in this part of the county seem to indicate that the coal is somewhat thinner near the edge of its area of deposition. It is commercially important, however, and will be mined when the thicker coal to the east has been extracted.

Present prospecting and mining are dependent largely upon the location of the principal transportation lines, and future roads will no doubt cause the exploitation of valuable coal resources west of the present mines.

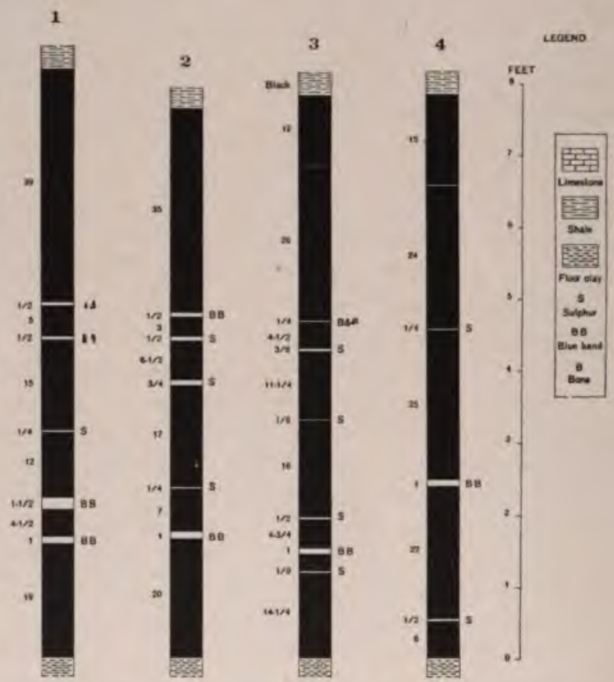

FIG. 11.—Graphic sections of coal No. 6 from measurements made in mines of Macoupin County.

1. Superior Coal Co., No. 3, Gillespie. Face main east, 4700 feet from shaft.
2. Carlinville Coal Co., Carlinville. Main south face, 5000 feet from shaft.
3. Consolidated Coal Co., No. 15, Mt. Olive. Room 20, off 3rd east, north.
4. Glenridge Coal Co., North mine, Virden. 1st. W. off 15th S. off main east.

PHYSICAL CHARACTERISTICS

Coal No. 6 is in Macoupin County physically similar to that in other parts of the district, and the natural division of the bed into three benches prevails (see figure 11). The top coal which is generally separated from the middle bench by a parting of pyrite, or in other places by charcoal, is composed of hard, bright coal usually free from impurities. Contrary to practice in the southern part of the State, the top coal is generally removed in mining. At the North

mine of the Illinois Collieries Company at Virden 15 to 18 inches of top coal is left wherever this is possible. In places flakes of calcium carbonate or calcium sulphate have been deposited in the cleavage faces, more especially near the top of the bed, probably from descending waters. The top coal is variable in thickness, but in most places it is less than 2 feet.

The middle bench contains the largest amount of impurities which consist of horizontal bands of pyrite, dirt, and bone. In many places the luster of the coal in the middle bench is duller than that of the top and bottom. The banded impurities are more or less irregular in position, but in some mines certain bands are persistent and are employed in placing shots to best advantage, especially if the band acts as a clean parting in the bed. Pyrite streaks of this type are often called "steel" bands by the miner. In Superior Coal Company's No. 3 mine at Benld, the so called "steel" band is about 5½ inches above the "blue band" and makes a clean parting at its horizon. Another characteristic parting lies from 15 to 30 inches below the top of the coal and may consist of pyrite, dirt, or charcoal.

Besides the persistent impurities mentioned above, the middle bench is characterized by a number of irregular bands of these materials, ranging in thickness from a knife edge to 2 inches. The larger ones are rejected in mining. The "blue band" is characteristic here as in other counties of the district. It averages about 1⅓ inches in thickness and is composed largely of fine-grained, gray shale, including horizontal streaks of sulphur. It is in the lowest third of the bed and its position averages about 20 inches from the bottom.

The bottom coal is generally somewhat harder than the middle, and it contains fewer dirt bands. In places near the contact with the floor black jack or bone is present to a thickness of several inches.

The following detailed sections were measured at the face in typical mines of Macoupin County:

Superior Coal Company, mine No. 3
Section of coal No. 6, face 5th E., 1st S

	Thickness *Inches*
Shale, black, roof	
Coal, bright, with gypsum flakes in cleavage planes toward top, a few charcoal bands; one small sulphur streak	30
Sulphur, in places dirt only, characteristic band	[illegible]
Coal, dull, laminated, ¼-inch charcoal band 6 inches from top; one or two irregular sulphur streaks	24
Sulphur, not continuous	¾
Coal, alternating bright and dull layers	12½
Sulphur, "steel-band" of miner; persistent, makes clean parting in coal	¼ to ½

	Thickness *Inches*
Coal, bright, clean	5½
"Blue band", sulphur, and gray shale	1½
Coal, bright clean and hard	24
Clay floor ... *Total thickness coal*	99½

Illinois Collieries Company, North mine, Virden
Section of coal No. 6, room 18, 5th right, off 15 S.

	Thickness *Inches*
Shale, black, 1 to 6 feet.	
Coal, clean, bright, one small sulphur band not regular; at bottom thin sulphur band which acts as parting for top coal	15
Coal, fairly clean, bright with one band of charcoal	11
Dirt, regular, called "drift band"	1
Coal, clean	9
Dirt, persistent in mines	1
All coal above, contains many small dirt and sulphur layers.	
Coal, clean, bright	14½
Sulphur, persistent, "steel band"	⅛
Coal, clean, bright	8
"Blue band", shale and sulphur, 2 to 3 inches in places	¾
Coal, cleaner, brighter. In places bottom part is replaced by bone or black jack	29
Clay floor ... *Total thickness coal*	89⅜

ROOF OF COAL NO. 6

The normal roof materials of coal No. 6 in Macoupin County are black shale next overlying the coal, followed by limestone cap rock. The shale is almost everywhere present, although in places it is scarcely more than a "draw slate". In the same mine the black, laminated shale may be 6 feet thick or it may be absent, in which latter case the limestone rests on the coal. When this is the condition, there are here and there a few inches of soft, limy, gray shale exhibiting but little cohesion, which underlies the regular cap rock. This so-called "clod" requires removal in mining. Where the shale is but 12 to 15 inches thick it is generally removed sooner or later, and the cap rock left as the roof.

Small "slip"-planes are present in the shale in most of the mines and "falls" are frequent. Figure 12 shows such a "slip", and the resultant "fall" in mine No. 5, Madison Coal Corporation, Mt. Olive.

In places part of the black shale appears to have been replaced by "white top," a light gray, clay shale, which seems to be definitely related to natural heating and in s me places to gob fires. After "falls" including this material, if it is not removed, chemical action

involving liberation of heat takes place in the loose mass, especially if the air is partly excluded by the plastic outer surface which results from exposure to the moist air of the mine. Heating continues, and if combustible material such as coal is mixed with the gob or if the mass rests against the rib, ignition is liable to occur. The constituents which cause the heating are not now known, but chemists of the cooperation are analyzing the shale and will no doubt be able to determine the chemical reactions involved.

FIG. 12.—Photo showing "slip" in roof and coal, and the "fall" resulting therefrom. Madison Coal Corporation, mine No. 5, Mt. Olive. (Courtesy Madison Coal Corporation.)

The limestone cap rock is almost everywhere present. Its thickness is extremely variable, and it is made up of several beds of limestone with partings of shale. The combined thickness of these beds is as much as 30 feet in places, but averages about 10 feet for the county. The quality of the limestone roof is dependent largely upon the nature of its bedding. Where it lies in regular layers and the parting between it and the coal is clean, it possesses a high degree of efficiency; where it is nodular and lacks uniform bedding planes, difficulty is experienced in supporting it. Both types are present in mine 5 of the Madison Coal Corporation at Mt. Olive.

In many places the black shale contains limy concretions or "niggerheads" which protrude into the coal. The irregularities produced by these concretions are not so large as the "rolls" which are kettle-shaped proturberances of the limestone into the coal. Generally the rolls affect only the upper part of the bed and give to the roof a decidedly rough and nodular appearance. In places, however, their size and number is so great as to interfere with mining operations, and in a few mines they have caused the abandonment of the parts most affected. Such was the result on the west side of the North mine, Illinois Collieries Company at Virden. In places immediately adjacent to the rolls slickensides are found in the coal and the laminations are but slightly downward. It is generally apparent that the material forming the roll was deposited in an actual depression in the mass of vegetal matter before it began to undergo pressure. As the overlying beds accumulated, the material now constituting the roll was depressed along with the coal and the small slip planes present are the result of adjustments incidental to the settling process.

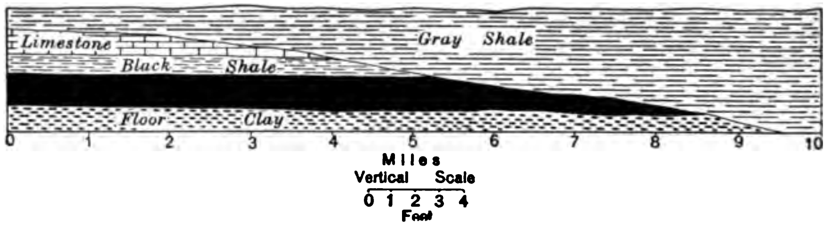

FIG. 13.—Sketch showing probable relation of erosion to the absence of roof limestone and coal in parts of Macoupin County.

An extensive area east and southwest of Carlinville has no limestone over the coal. Holes in sec. 10, T. 8 N., R. 7 W.; sec. 22, T. 9 N., R. 7 W.; and sec. 36, T. 10 N., R. 7 W. all show limestone near the coal. These holes lie in a general north-south direction. Two or three miles east, three others were drilled in secs. 18 and 32, T. 9 N., R. 6 W. and in sec. 32, T. 10 N., R. 6 W., and in all of these only shale from 40 to 50 feet thick forms the roof. Somewhere between these last holes mentioned and the Montgomery County line the coal, as well as the limestone, is absent. This barren area is part of the similar, but larger, region in western Montgomery County, described in the report on that county. The position of the western boundary of the barren area can not be drawn accurately with the available drill records, but its approximate location is indicated on the large map. It is believed that the absence of the coal and limestone is due to erosion which was active at some time after the roof limestone had been deposited. The general relations are illustrated in figure 13.

FLOOR OF COAL NO. 6

The clay underlying the coal in Macoupin county is relatively thin. In 16 mines which have been examined it varies in thickness from a knife edge to about 3 feet, the average being about 1 foot. Below the clay in most places a limestone of variable thickness and character is reported. Many of the drill holes do not penetrate this horizon, but it is known in most of the mines in the county. About three feet of dove-colored, compact, non-crystalline limestone is visible under the clay in part of mine No. 15, Consolidated Coal Company at Mt. Olive. Most of the clay is impure, especially where it is thin, and it is not promising from a commercial standpoint.

COALS BELOW NO. 6

Most of the holes that penetrate the principal coal horizons were drilled in search of oil and are located in the vicinity of Carlinville in Tps. 9 and 10 N., R. 7 W. Even in these townships no coal below No. 6 can be traced for any distance. No. 5 coal, said by Worthen to outcrop on Hedges Creek 30 to 40 feet below No. 6, does not appear to exist to the east. A coal ranging in thickness from 2 to 4 feet was noted from 90 to 110 feet below No. 6 in sec. 24, T. 10 N., R. 7 W., sec. 29, T. 9 N., R. 7 W., in sec. 2, T. 9 N., R. 9 W. and in sec. 14, T. 10 N., R. 7 W. The interval between this bed and coal No. 6 makes its correlation as coal No. 5 almost impossible. The only other horizon that shows any promise is from 200 to 250 feet below coal No. 6. Six of the deeper records note a coal in this, the position of coal No. 2 (Murphysboro). Its thickness varies from 3 to 5 feet, but the measurements are from the churn drill and are not regarded as authoritative. A complete test of any part of the county for the determination of its entire coal resources would involve the drilling of holes to a depth of 250 feet below coal No. 6 the main coal of the region. Until the supply of this latter bed is reduced however, it is doubtful if many tests will be continued below its horizon.

MADISON COUNTY

PRODUCTION AND MINES

Production in tons, year ending June 30, 1913.... 3,890,639
Average annual production, 1908 to 1913......... 3,615,309
Total production, 1881 to 1913.................56,005,118

Madison County produced 6.1 per cent of the total output for Illinois during the year ended June 30, 1913. Twenty-seven mines were operating, eleven of which produced more than 100,000 tons each, and one, New Staunton Coal Company, No. 1 at Livingston, had the largest

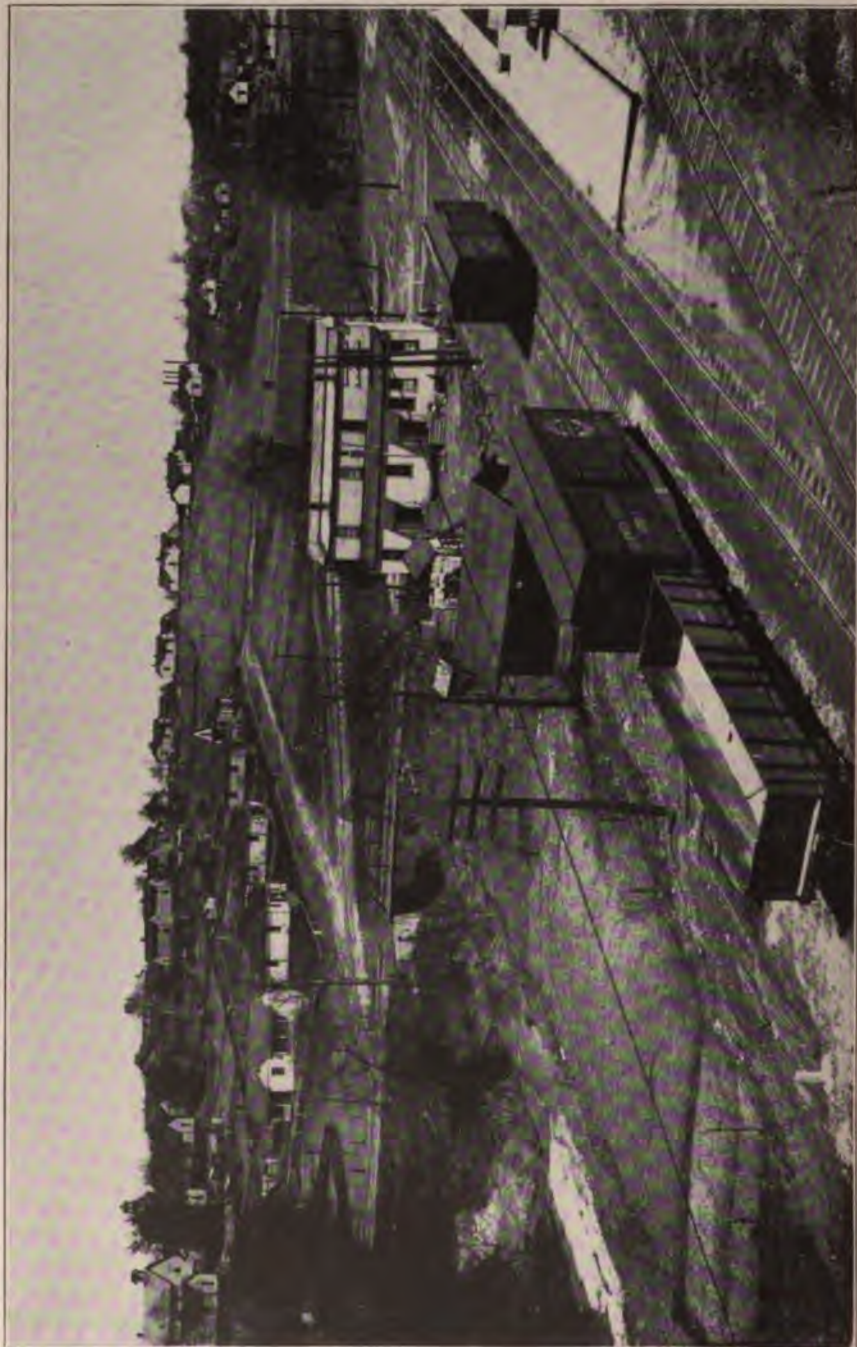

FIG. 14.—View of Glen Carbon, a typical mining town in Madison County. (Courtesy Madison Coal Corporation.)

TABLE 7 *List of shipping mines, Madison County, 1913*

Map No.	Company	Mine	Location ¼	¼	Sec.	T. N.	R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	New Staunton Coal Co.	1	NE	SE	16	6	6	586	277	309	6	.	848,715
2	Mt. Olive & Staunton Coal Co.	2	NW	NW	10	6	6	599	293	306	7	..	518,610
3	Lumaghi Coal Co.	2	SW	SW	25	3	8	500	188	312	8	..	377,798
4	Donk Bros. Coal & Coke Co.	2	cen	E½	11	3	8	573	238	335	7	.	361,169
5	Donk Bros. Coal & Coke Co.	1		NW	22	3	8	525	133	392	7	.	309,832
6	Madison Coal Corporation	2	SW	SE	34	4	8	476	93	383	6	6	265,504
7	De Camp Coal Mining Co.	1	SW	NE	18	6	6	622	274	348	5	4	232,974
8	Donk Bros. Coal & Coke Co.	3	NE	NE	8	3	7	568	268	300	5	..	187,125
9	Kerns-Donnewald Coal Co.	Worden	SW	SW	25	6	7	590	263	327	7	..	185,092
10	Madison Coal Corporation	4		NW	35	4	8	480	174	306	6	.	167,813
11	Mt. Olive & Staunton Coal Co.	1	NE	NW	8	6	6	612	280	332	6	2	144,981
12	Lumaghi Coal Co.	3	SE	SW	26	3	8	495	165	330	7	6	80,151
13	W. S. Walker	Henrietta	NE	SW	1	4	8	590	174	416	6		63,000
	City Coal Co.	Edwardsville		..	.		.		216	..	6	5	47,636
	Edwardsville H. & T. Coal Co.	Edwardsville					..		130		5	..	32,582
	Brookside Coal Co.	Troy				..	..		285	..	5	.	10,570

output of any single mine in the State, the average being 4,003 tons per day or a total of 848,715 tons for the year.

The mines are located in two areas, one at the southern side of the county and the other in the northeast corner. All are working bed No. 6 or the "Belleville" coal. Figure 14 is a photograph of Glen Carbon, Madison County, one of the better class mining towns. Table 7 is a list of mines active during 1913 and data concerning them.

Coal-bearing Rocks

Madison County is located on the western boundary of the Illinois coal basin. The outcrop of the basal "Coal Measures" extends north and south through the western part of the county. Its position is obscured by the alluvial filling of American Bottom which extends from Alton south to the mouth of the Okaw in Randolph County. Its width in Madison County varies from one to six miles.

The rocks in the flood plain of the Mississippi were eroded to a depth varying from 50 to 150 feet before the alluvium was deposited; consequently the veneer of "Coal Measures" rocks was largely washed away. Figure 15 shows the relation of the valley filling to the underlying rocks along a line from Monks Mound N. 70° E. to the bluffs of the Mississippi.

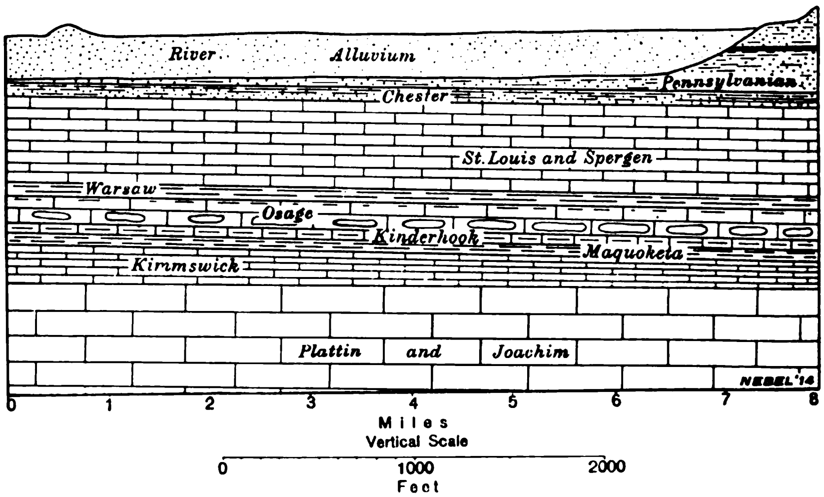

Fig. 15.—Sketch showing relation of coal No. 6 to river alluvium and to underlying beds in Madison County. (After Fenneman.)

Coal No. 6, which outcrops in the base of the bluffs south of Caseyville, is covered by alluvium, north of the southern boundary of *Madison* County and extends a short distance west of the bluffs. Its

line of outcrop parallels the bluffs, but sufficient drilling has not penetrated the alluvium to determine its exact position.

The coal-bearing beds, which form but a veneer in the western part of the county, increase rapidly in thickness to the east, because of the pronounced dip in that direction. The increase in the thickness is gradual and these beds measure about 700 feet along the eastern boundary of the county. Coal No. 6, which comes to the surface at the base of the Mississippi bluffs, is 230 feet below the surface at Edwardsville, and about 400 feet deep in the eastern part of the county.

The glacial covering is variable in thickness but reaches more than 100 feet in places. In the eastern part it extends down to the Carlinville limestone which forms the bed rock in parts of R. 5 W.

The beds above coal No. 6 consist largely of shale. The limestone overlying the coal is persistent, and the thin coal from 20 to 40 feet above is noted in several of the logs. The red or variegated shales described in an earlier part of the report lie a short distance above the coal just mentioned. The Carlinville limestone, averaging about 9 feet in thickness, is from 250 to 280 feet above coal No. 6. It is present only in the eastern part of the county since it rises to the west and would outcrop in a general north-south line were it not covered by glacial drift except where the latter has been eroded. From 30 to 40 feet below the Carlinville limestone, and separated from it by shale, there is present in many places a bed of coal averaging about 18 inches in thickness, and a few drillers report a thin bed 150 to 180 feet above coal No. 6, corresponding to that mentioned in the report on Christian County as coal No. 8. None of the beds above coal No. 6 are commercial.

Sandy shales and sandstones predominate below the Belleville coal. Six holes which penetrate most of the coal-bearing strata fail to show a persistent coal below No. 6. At Highland two coals separated by 10 feet of fire clay and 5 feet of sandstone lie 200 feet below the horizon of coal No. 6, the latter coal being absent at this place. The upper bed is 1 foot 10 inches thick; the lower, 1 foot 2 inches. Their position and occurrence correlate them as the two benches of coal No. 2 (Murphysboro). The other test holes do not record such beds.

At Cantine a 2-foot coal lies 105 feet below coal No. 6, and at Livingston several thin beds are reported in a zone 125 to 150 feet below the Belleville coal. The coals at both these horizons appear to be lenticular and will probably not prove to be commercial.

The following is the record of a diamond-drill hole put down at Livingston by the New Staunton Coal Company:

Record of New Staunton Coal Co. drill hole

Location—NE.¼ SE.¼ sec. 16, T. 6 N., R. 6 W.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Soil	2	..	2	..
Clay, yellow	16	..	18	..
Sand and gravel	7	..	25	..
Clay, blue	53	..	78	..
Clay, yellow	30	..	108	..
Limestone	1	..	109	..
Shale, soft, yellow	22	..	131	..
Sandstone	3	..	134	..
Shale, sandy	54	..	188	..
Shale, blue	15	..	203	..
Shale, clay, soft	11	..	214	..
Shale, soft lime	6	..	220	..
Shale, pebbles	9	..	229	..
Shale, sandy	2	..	231	..
Shale, clay	2	..	233	..
Shale, red, soft	4	..	237	..
Limestone	4	..	241	..
Shale, blue	13	..	254	..
Limestone	1	6	255	6
Coal	.	8	256	2
Shale, clay	7	4	263	6
Limestone	2	..	265	6
Lime shale	2	..	267	6
Limestone	7	..	274	6
Shale, black	2	..	276	6
Coal (No. 6.)	6	..	282	6
"Blue band" (No. 6.)	2	1	282	7
Coal (No. 6.)	1	..	283	7
Fire clay	2	5	286	..
Limestone	7	..	293	..
Shale, blue, soft	6	..	299	..
Shale, blue	10	..	309	..
Shale, black	1	..	310	6
Shale, clay	4	..	314	6
Shale, blue	4	..	318	6
Lime shale	1	6	320	..
Shale, sandy	15	..	335	..
Shale, blue	37	4	372	4
Coal	..	8	373	..
Shale, gray	..	4	373	4
Coal	..	8	374	..
Shale, blue	34	..	408	..
Shale, sandy	..	6	408	6
Shale, black	..	6	409	..
Coal	..	5	409	5
Shale, black	..	7	410	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Coal	2	8	412	8
Shale, dark blue	1	4	414	..
Clay, shale	3	..	417	..
Limestone	2	6	419	6
Coal	..	9	420	3
Blue band	..	1	420	4
Coal	1	3	421	7
Coal, shaly	..	5	422	..
Shale, black	..	6	422	6
Limestone	3	..	425	6
Shale, clay	5	6	431	..
Limestone	1	..	432	..
Coal	1	2	433	..
Shale, clay	8	10	442	..
Shale, dark, with sandstone partings	15	..	457	..
Limestone	..	6	457	6
Shale, dark, with sandstone partings	1	..	458	6
Limestone	1	6	460	..
Shale, blue	6	2	466	2
Coal	..	6	466	8
Sandstone	..	1	466	9
Coal	..	6	467	3
Lime shale	3	9	471	..
Shale, soft, brown	19	.	490	..
Shale, black	11	..	501	..
Sandstone	34	..	535	..

Gas at 535 feet, 100 lbs. pressure for one month.

The record below is from a well drilled in 1889 for the Helvetia Milk Condensing Company at Highland. The absence of coal No. 6, which should be about 310 feet from the surface, is explained under the subject "Distribution and depth" in this chapter.

Record of Helvetia Milk Condensing Co. drill hole
Location—SW.¼ SE.¼ sec. 32, T. 4 N., R. 5 W.

Description of Strata	Thickness		Depth	
	Ft.	*In*	*Ft*	*In*
Pennsylvanian strata—				
Drift	66		66	
Limestone (Carlinville ?)	4		70	
Black shale	3		73	
Fire clay	7		80	
Shale	16		97	
Shale, black	6		103	
Limestone, brown	28		131	..
Shale	55		186	..
Sand (water)	73		259	..

Description of Strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Shale	10	..	269	..
Fire clay?	10	..	279	..
Sand, red	2	..	281	..
Limestone	22	..	303	..
"Slate"?	5	..	308	..
Sand (horizon of coal No. 6)	12	..	320	..
"Slate"?	12	..	332	..
Sand	6	..	338	..
Shale	20	..	358	..
Sand (water)	39	..	397	..
"Slate"	20	..	417	..
Sand (water)	40	..	457	..
"Slate," black	25	..	504	..
Coal (No. 2?)	1	10	506	..
Fire clay	10	..	516	..
Shell sand	5	..	521	..
Coal	1	..	522	..
Fire clay	4	..	526	..
"Slate," black	55	..	582	..
Sand (water)	25	..	607	..
"Slate," black	25	..	632	..
Shale	75	..	707	..
Limestone	4	..	711	..
"Slate"	30	..	741	..
Sand (water)	29	..	770	..
Shale	27	..	797	..
Mississippian strata—				
Chester group—				
Limestone, brown	6	.	803	..
"Slate"	4	..	807	..
Limestone	8	..	815	..
Sand, red	2	..	817	..
"Slate," red	4	..	821	..
Sand (water)	8	..	829	..
"Slate"	3	..	832	..
Sand, brown (water)	20	..	852	..
Sand, red	12	..	864	..
Shale	6	..	870	..
Sand, brown (water)	19	..	889	..
Sand, green, shaly	15	..	904	..
Sand, green	18	..	922	..
Sand, white (water)	72	..	994	..
Sand, white	22	..	1014	..
St. Louis formation—				
Limestone	75	..	1089	..

In the Highland well the Chester beds consisting of interbedded shales, some of which are red sandstones and limestones, measure 213

feet. The top of the Chester is 797 feet below the surface and the "Big Lime" which underlies the Chester is found at 1010 feet.

Geological Structure

In common with the beds of adjacent counties, the rocks of Madison County dip eastward at an average rate of about 13 feet per mile. A slight reversal of this dip is apparent in the south-central part of the county where the axis of the Belleville anticline crosses the boundary and extends northeast for a few miles. Its exact shape and size in Madison County are not well known owing to a lack of drilling data, but it has not proved to be commercially important. The beds in the eastern tier of townships are almost horizontal.

Although many small slips affect the coal beds, no major faults have been found in the mines of the county. The roof irregularities known as "faults" by the miners will be discussed under the proper heading in this chapter.

Coal No. 6

DISTRIBUTION AND DEPTH

Coal No. 6 underlies approximately three-quarters of the county. Its western boundary is indicated on the large map accompanying this report. As has been mentioned, it outcrops near the base of the bluffs bordering American Bottoms, and dips to the east at a rate sufficient to carry it 400 feet below the surface along the eastern boundary.

The area in which coal No. 6 is thin or absent in Montgomery and Christian counties extends southward probably through the eastern tier of townships in Madison County. The bed is known to be absent in sec. 3, T. 6 N., R. 5 W., and for some distance east and south as shown on the map. It is also absent at Highland, and it is thin inside of the area shown near Aviston in Clinton County. Between Highland and the northeast corner of the county no drilling has been done, but the alignment of the barren and thin areas in this part of the State, leaves small room for doubt that they are all connected. The tentative boundaries are drawn on the map according to the best information available at this time. They are in no way final but will be revised from time to time as new data are available. Although it is believed that this barren zone is continuous through the eastern part of the county, its size and shape are not known. It is reasonable to suppose that between Highland and the northeast part of the county its width is about 2 or 3 miles, which is the average for the places mentioned.

THICKNESS AND CHARACTER

Coal No. 6 averages slightly more than 6 feet in thickness in the mines of the county. At Collinsville the average is about 7 feet, but the bed thins somewhat towards the northeast. No information is available as to the thickness of the bed northwest of Edwardsville, but it is likely that near the outcrop it has been considerably affected by erosion prior to the deposition of the glacial drift.

Figure 16 shows the physical character of coal No. 6 in some of the mines of Madison County.

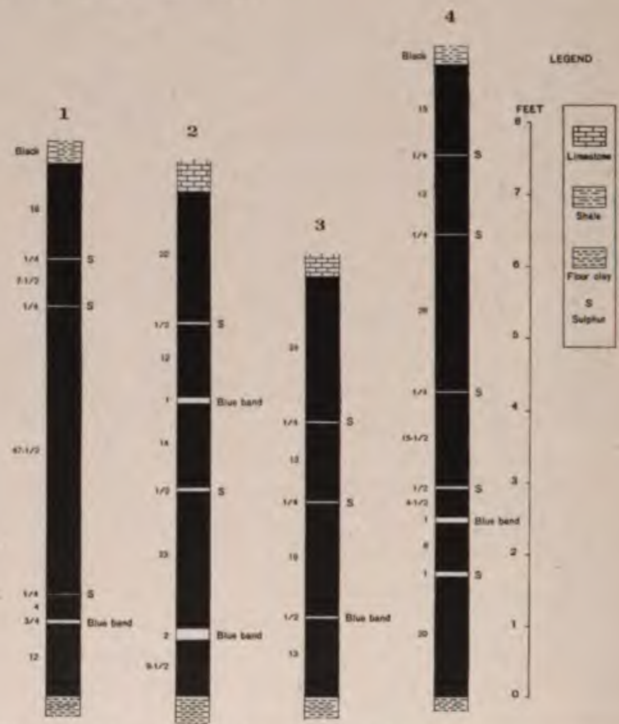

FIG. 16.—Graphic sections of coal No. 6 from measurements made in the mines of Madison County.

1. Mt. Olive and Staunton Coal Co., 2, Williamson. Entry face, main north, 3500 feet from shaft.

2. New Staunton Coal Co., Livingston. 1st. right off main west, face 4000 feet from shaft.

3. Madison Coal Corporation, No. 2, Glen Carbon. Face 8th. N. off 3rd. E., 3500 feet from shaft.

4. Lumaghi Coal Co., No. 2, Collinsville. 1st. E. off main S., 5700 feet from shaft.

Over most of the county coal No. 6 compares favorably with that of the entire Belleville district. The usual three benches are recog-

nized (see figure 16), but the top coal is seldom left for roof. The middle bench especially is characterized by a number of pyrite bands.

The following section was measured in mine No. 2, Lumaghi Coal Company, Collinsville.

Section of coal No. 6; main east face; August, 1912

	Ft.	In.
Top coal, bright, clean	1	8
Sulphur streak	..	..
Coal, fairly clean, bright, soft, brown streak	1	½
Coal, soft, with few dirt bands	3	8½
"Blue band", shale	..	1½
Coal, harder than above	1	10½
	8	5

About 23 inches above the "blue band" there is a streak of sulphur which is more or less continuous and reaches a thickness of ½ inch in places. In the mine it has been observed that the coal below this sulphur contains a larger number of dirt bands than does the upper part of the bed. The persistent nature of the sulphur band makes it possible to place shots above it, and to use it as a parting in the bed. The face of the coal is streaked with a large number of pyrite bands, most of which are small lenses traceable for only short distances.

The following section was measured in the mine of the New Staunton Coal Company, Livingston:

Section of coal No. 6; room 1, 11 south entry off main east

	Ft.	In.
Top coal, bright, clean, impurities mostly facings of gypsum and calcite	1	½
Coal with small sulphur streaks	2	1
Sulphur band, persistent	.	½
Coal with many dirt streaks	.	22
Sulphur band, persistent, variable in thickness		..
Coal, clean	..	7
"Blue band", gray shale and sulphur		1½
Coal, bright and clean	.	10
	6	5½

ROOF AND FLOOR

The regular roof of coal No. 6 consists of gray or black shale of variable thickness overlain by limestone ranging in thickness from a few feet to as much as 30 feet. In many places the immediate roof is so thin that it is really a "draw slate," and in others the limestone rests on the coal itself. In the latter case the contact between the coal and the limestone is generally irregular, and the bottom of the cap

rock consists in places of poorly bedded, impure limestone known as "clod." The black shale does not ordinarily exceed 8 feet in thickness, but in mine No. 3, Donk Brothers, the soapstone roof is reported to be 50 feet thick. The black shale tends to fall easily, especially after exposure to the air.

Figures 17 and 18 are from photographs by the Madison Coal Corporation. They show the character of the shale-limestone roof not only for Madison County but in a general way for district VII.

The limestone generally exhibits sufficient cohesion to form a strong roof, but in places, as in New Staunton Coal Company's mine No. 1 at Livingston, both the limestone and shale cause trouble by falling in large masses, one of which was 50 feet long and 30 feet high. Slip planes in the roof are responsible for dangerous falls and are especially feared because no evidence of their existence is known until the fall has taken place.

Besides the unevenness of the contact between the limestone and the underlying shale, it is not unusual to find the limestone protruding down into the coal as a roll, actually replacing a large amount of the coal itself. Such features affect the coal for only short distances. In a few places it seems to be clear that the limestone was deposited on an eroded surface and that the accumulating pressure was responsible for the slickensides present. In other cases, the black shale forms the lowest part of the roll and its bedding is parallel with that of the coal. Slickensides in both the coal and the roll give evidence of considerable pressure.

Small faults having a throw of half the thickness of the bed are not uncommon throughout the county, but the limestone rolls are more numerous in the northeastern mines.

Coals below No. 6

The few holes in Madison County that have penetrated the entire thickness of coal-bearing beds furnish only a small amount of information regarding coals below No. 6. At Highland, coal No. 2 is probably represented by two coals separated by 15 feet of fire clay and sand, the upper bed being 1 foot 10 inches thick and the lower measuring 1 foot 2 inches. At Livingston in the northeastern part of the county five coal horizons were penetrated below coal No. 6, the beds ranging in thickness from 1 foot 2 inches to 3 feet 1 inch; but all show numerous partings of shale. It is not possible to correlate them with other beds in the county, and it is probable that they are lenticular. At Cantine a bed 2 feet 6 inches thick was found 105 feet below coal No. 6. Coal No. 5 is not developed in the area tested up to the present time.

FIG. 17.—Photo showing clod-limestone roof, Madison Coal Corporation, mine No. 4, Glen Carbon. (Courtesy Madison Coal Corporation.)
Note difficulty experienced in holding up clod.

FIG. 18.—Photo showing nature of bedding in black shale roof. (Courtesy Madison Coal Corporation.)

MARION COUNTY

Production and Mines

Production in tons, year ended June 30, 1913..... 1,188,551
Average annual production, 1909 to 1913........ 1,107,319
Total production, 1881 to 1913.................20,228,469

During the year ended June 30, 1913, Marion County produced **1,188,551** tons of coal or 1.92 per cent of the State's total output. **Six mines were in** operation, all in coal No. 6, and the annual pro**duction ranged** from 390,106 tons down to 84,614 tons.

Table 8.—*List of shipping mines, Marion County, 1913*

No. Map	Company	Mine	Location ¼	¼	Sec.	T. N.	R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness		Production 1913
								Feet	Feet	Feet	Ft.	In.	Tons
1	Marion County Coal Co.	[illegible]	NE	NE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	Chicago Sandoval Coal Co.	2	SW	SW	17			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
3	Odin Coal Co.	Odin	NW	NW	[illegible]				[illegible]	[illegible]	[illegible]		[illegible]
4	Centralia Coal Co.	2	NW	NW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	Centralia Coal Co.	4	SW	NE	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Chicago Sandoval Coal Co.	1	SW	NE	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]

Coal-bearing Rocks

The coal-bearing beds in the western part of Marion County are **well known,** since most of the drill holes penetrate all of the Pennsylvanian **and** part of the underlying Mississippian rocks. In drilling **for oil, little attention** is given coals other than No. 6, and it is be**lieved that the** diamond drill will prove the existence of the beds not **yet reported.** The Pennsylvanian formations underlie all of the **county below the** glacial drift, which averages less than 100 feet in **thickness, although** thicknesses of 150 feet are not uncommon.

Coal No. 6, the most important bed in the county, varies in depth **from 500 feet in** the western side to almost 900 feet in the eastern **part. The limestone** cap rock is generally present, and another more

or less persistent limestone probably the Carlinville, lies about 350 feet above the coal. Other thin limestones are reported at various horizons, but these cannot be successfully correlated from one hole to another. The greater part of the section is composed of shales and minor beds of sandstone. Two beds of coal above coal No. 6 may be recognized in most of the shaft logs and diamond-drill records. The first of these lies about 35 feet above coal No. 6, and probably represents coal No. 7. A few of the logs show another thin bed 10 to 15 feet above coal No. 7, attaining a thickness of 1 foot 4 inches. About 200 feet above coal No. 6 a thin coal is reported in scattered prospect holes and shaft logs, but it is not noted in any of the oil holes. This bed is in most places thin, but its commercial utilization was attempted by the Centralia Coal Company at their mine No. 2, where it is locally developed to an unusual thickness. The shaft was later sunk to coal No. 6 and the upper levels were abandoned.

The coal-bearing formations were deposited on an eroded surface of Chester rocks, and as a result the base of the Pennsylvanian is extremely irregular, being from 400 to 700 feet below coal No. 6, the greater thicknesses representing beds deposited in former valleys. The lower part of the coal-bearing rocks is composed largely of sandstone, no bed being traceable for any considerable distance. Shales are present but not so abundantly as in the section above coal No. 6. The coals below No. 6 are insufficiently prospected since most of the deep holes have been drilled for petroleum, little or no attention having been given to the position of thickness of the coals. For a thorough investigation of the coal beds it is necessary to drill carefully through the beds for a distance of 300 feet below coal No. 6, in order to determine the existence of coals No. 5 and No. 2 which are undoubtedly the most persistent. In prospecting for coal in Marion County, holes should be discontinued at a depth of 325 feet below coal No. 6. Bed No. 5 whose horizon averages 50 feet below coal No. 6 would be penetrated in all coal tests.

The following logs are representative of the beds in various parts of Marion County.

Record of Centralia Coal Co., shaft No. 2

Location—NW.¼ NW.¼ sec. 19, T. 1. N., R. 1 E.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
"Hardpan"	2	6	2	6
Clay, yellow	9	6	12	..
"Soapstone"	11	..	23	..
"Slate", blue	47	..	70	..
Shale	..	8	70	8

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Limestone	1	6	72	2
Coal	..	8	72	10
"Slate", blue	24	6	97	4
"Soapstone"	2	..	99	4
Limestone rock	5	6	104	10
Sandstone, hard	5	..	109	10
Coal	..	2	110	..
Sandstone, soft	6	..	116	..
Coal	..	6	116	..
Sandstone	2	6	119	..
Coal	..	2	119	2
"Soapstone"	4	..	123	2
Limestone rock	2	..	125	2
Sandstone	12	2	137	4
Rock, blue	1	6	138	10
Fire clay	2	..	140	10
"Soapstone"	15	6	156	4
Slate, blue	..	29	185	4
Lime rock	11	..	196	4
Shale	5	6	201	10
Coal	..	5	202	2
"Soapstone"	4	..	206	2
Sandstone	10	..	216	2
"Slate"	50	..	266	2
Limestone	1	..	267	2
Shale	2	..	269	2
"Soapstone"	3	..	272	2
Sandstone	24	..	296	2
Slate", blue	79	.	375	2
Coal	1	2	376	4
"Soapstone"	3	..	379	4
Conglomerate of limestone	8	.	387	4
"Slate", light colored	10	..	397	4
Sandstone	56	..	453	4
"Slate", dark colored	43	..	496	4
"Slate", black, with carbonate of iron	6	..	496	10
Coal	1	½	496	½
"Soapstone" with sulphide of iron, soft, stratified rock, a mixture of kidney ore and fire clay	11	.	510	11½
Sandstone and sulphide of iron	1		511	11½
"Slate" deep black	1		512	11½
Fire clay	1	6	514	5½
Limestone, gray	2	..	516	5½
Shale, variegated	8	.	524	5½
Coal	2	..	526	5½
Marble limestone	8	..	534	5½
Shale, blue	2	..	536	5½
Limestone, gray	4	6	540	11½

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Shale, black	2	6	543	5½
Limestone, gray	4	..	547	5½
Shale, black	12	..	559	5½
Limestone, blue	7	..	566	5½
Shale, bituminous	2	6½	569	..
Coal (continuation with diamond drill in bottom of shaft)	7	..	576	..
Lump fire clay	10	..	586	..
Sand, shale, and lime (mixed)	3	..	589	..
Lime shale	1	2	590	2
Coal and slate	..	4	590	6
Clay shale	62	6	653	.
"Slate", black	5	..	658	..
Coal	2	2	660	2
Clay shale, dark	2	10	663	..
Limestone	1	4	664	..
Clay shale	11	8	676	..
"Slate", gray	7	..	683	..
Sand shale	14	..	698	..
Clay shale	2	3	700	3
"Slate", black	..	9	701	..
Coal	1	3	702	3
Fire clay, soft brown	3	9	706	..
Conglomerate, lime, and shale	1	..	707	..
Sand shale	9	..	716	..
Shale, dark gray	4	..	720	..
"Slate", black	..	8	720	8
Coal	..	4	721	..
Shale, gray	1	..	722	..
Coal	..	1	722	1
Sand shale	5	11	728	..
Shale, dark	2	..	730	..
"Slate", black	1	2	731	2
Coal	1	3	732	5
Shale, gray	1	7	734	..
Sand shale	4	..	738	..
Shale, gray, 2 partings	3	6	741	6
Coal	..	6	742	..
Sandstone, gray	5	..	747	..
Sand shale	2	..	749	..
Clay shale	3	6	752	6
Coal	..	6	753	..
Fire clay	3	..	756	..
Clay shale	2	..	758	..
"Slate", black	1	3	759	3
Coal	1	3	760	6
Clay, shale, brown	4	6	765	..
Fire clay, white	1	..	766	..
Fire clay	3	6	769	6

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Limestone	1	6	771	..
Clay shale	2	..	773	..
"Slate", black	1	7	774	7
Coal (No. 6)	6	11	781	6
Shale, dark	1	6	783	..
Sand shale	1	4	797	..
Sandstone	16	..	813	..
Shale, gray	4	..	817	..
Clay shale	25	6	842	6
Conglomerate, sand and bowlders	6	6	849	..
Sand shale	2	..	851	..
Clay shale	12	8	863	..
Coal	..	4	864	..
Fire clay	..	2	864	2
Clay shale	3	7	867	9
Sandstone	18	3	886	..

Record of shaft No. 1, Odin Coal Company
Location—NW.¼ NW.¼ sec. 13, T. 2 N., R. 1 E.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Surface soil	1	10	1	10
"Hardpan"	..	10	2	8
Clay, yellow	7	..	9	8
Clay, sand, yellow	4	6	14	2
Clay, blue, gravel	20	..	34	2
Clay, blue	78	..	112	2
Clay, brown	2	6	114	8
Clay, blue, mud and sand	6	..	120	8
Quick sand	6	..	126	8
Gravel, cemented	1	..	127	8
Lime rock	1	..	128	8
"Soapstone"	..	6	129	2
Lime rock	1	..	130	2
"Soapstone"	2	6	132	8
Lime rock	7	..	139	8
"Soapstone"	7	6	147	2
Sandstone	10	..	157	2
Shale	6	..	163	2
Coal	..	4	163	6
"Soapstone"	4	..	167	6
"Slate", blue	19	..	186	6
"Soapstone"	4	..	190	6
Shale	3	..	193	6
Fire clay	4	..	197	6
Lime rock, blue	8	1	205	7
"Slate", blue	3	..	208	7
Coal	..	2	208	9

Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
Fire clay	..	6	209	3
Sand shale	14	2	223	5
Coal	..	7	224	..
Sand shale	11	..	235	..
Sand, rock, and shale	4	..	239	..
Sand shale	5	..	244	..
"Slate", blue	9	..	253	..
Rock and gravel	1	6	254	6
Fire clay	2	6	257	..
Fire clay and bowlders	2	..	259	..
Slate, dark blue	58	..	287	..
Limestone (Shoal Creek)	10	..	297	..
"Slate", black	3	..	300	..
Coal	..	2	300	2
Fire clay	5	..	305	2
Sand rock	4	6	309	8
Sand shale	52	..	361	8
"Slate", blue	10	..	371	8
Rock and gravel	1	4	373	..
Lime rock	..	6	373	6
Fire clay	5	..	378	6
Conglomerate slate and lime rock	8	..	386	6
"Soapstone"	10	..	396	6
Sand rock	63	..	459	6
"Slate", blue	28	..	487	6
"Slate", blue, and boulders	7	..	494	6
Coal	..	10	495	4
Fire clay	2	6	497	10
Conglomerate sand and lime rock	8	..	505	10
Sand rock	5	..	510	10
"Slate", gray	13	..	523	10
Sand, shale, and lime rock	46	..	569	10
"Slate", blue	44	..	613	10
Clay shale, light	1	6	615	4
Conglomerate clay and gravel	5	..	620	4
Fire clay	6	..	626	4
Lime rock, hard	9	6	635	10
Lime rock, soft	4	6	640	4
Shale, blue	10	6	650	10
Coal	1	4	652	2
Fire clay	1	8	653	10
Conglomerate	2	..	655	10
Shale, dark blue	7	..	662	10
Coal (No. 7)	3	2	666	..
Fire clay	2	..	668	..
Clay, pebbly	2	..	670	..
Lime rock, light	1	..	671	..
Clay shale	1	..	672	..
Lime rock	5	..	677	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Shale, blue	..	4	677	4
Limestone	..	4	677	4
Shale, blue	..	9	678	5
Limestone	1	3	679	8
Shale, blue	1	3	680	1
Lime rock, white	6	..	686	11
Lime rock, mottled	3	..	694	11
Lime rock, dark gray	..	10	695	9
Shale, black	14	..	709	9
Coal (No. 6)	7	6	717	3

Record of Ohio Oil Co. well

Well—Guthrie No. 1.

Location—SW.¼ SW.¼ sec. 28, T. 2 N., R. 1 E.

(Descriptions by J. A. Udden)

Description of Strata	Thickness *Feet*	Depth *Feet*
Pennsylvanian strata—		
Surface material	20	20
Bowlder clay	6	26
Bowlder clay, blue	4	30
Bowlder clay, washed	10	40
Drift	10	50
Shale, micaceous, sandy	5	55
Sandstone	5	60
Shale	10	70
Shale, unctuous, light bluish	15	85
Shale, gray, micaceous	5	90
Shale, gray, micaceous, sandy	5	95
Shale, unctuous, blue	5	100
Shale, dark gray, micaceous	5	105
Shale, bluish gray, unctuous	25	130
Sandstone, sandy, fossiliferous, and shale with gray sandstone with infiltrated lime	5	135
Shale, dark gray, unctuous	5	140
Shale, dark gray, stiff	10	150
Lacking	20	170
Coal, impure, and fire clay	5	175
Fire clay, greenish gray	5	180
Limestone, brecciated, gray and black shale	5	185
Limestone, gray, sandy, with fragments of shells	5	190
Sandstone, gray, micaceous and sandy shale	5	195
Shale, sandy	5	200
Shale, dark gray	5	205
Shale, micaceous, sandy	25	230
Sandstone, sandy, showing shreds of carbonaceous material	10	240
Shale, dark gray	10	250

Description of Strata	Thickness Feet	Depth Feet
Shale, black, coaly	5	255
Another sample with same number, but probably coming from below this, consists of gray shale and sandy calcareous rock.		
Shale, gray, sandy, micaceous, and shale sandstone filled with interstitial lime	5	260
Shale, gray, clay, some limestone and black shale	5	265
Shale, micaceous, sandy	5	270
Sand, gray and white laminated	5	275
Shale, dark, stiff	15	290
Shale, dark, micaceous	10	300
Shale, dark, stiff	15	315
Shale, dark, stony, like the preceding	25	340
Shale, gray, stiff	5	345
Shale, gray	15	360
Limestone, gray and white, with coal and fire clay	5	355
Fire clay, coal, limestone, etc	5	60
Fire clay, shale, and siderite concretions	5	365
Sandstone and fire clay	5	370
Shale, gray, sandy	5	375
Shale, sandy, and sand	5	380
Sand containing carbonaceous material	5	385
Shale, gray, micaceous sand	20	405
Shale, gray	5	410
Shale, gray, sandy	35	445
Shale, dark gray	15	460
Shale, black, "clod" with a small gasteropod, small *Athyris* umbo, a crinoid stem and coal	5	465
Sandstone, nodular calcareous, and impure sandstone	5	470
Shale, dark and siderite	10	480
No sample	5	485
Shale, black	5	490
No sample	5	495
Shale, black, calcareous rock and some white limestone	5	500
Shale, gray, sandy material, some white limestone and some black shaly calcareous rock. *Fusulina*, *Chonetes punctatus*, and crinoid stems noted	5	505
Sandstone, gray, and dark shale—a few bits of limestone	5	510
Shale, dark, and some coal. A few pieces of white limestone	5	520
Shale, gray sandy, some black shale, and bits of yellowish-white limestone. Pyrite noted	5	525
Shale, black	5	530
No sample	5	535
Shale	5	540
Shale, dark gray and black	5	545
No sample	5	550

Description of Strata	Thickness *Feet*	Depth *Feet*
Shale, gray	5	555
Shale, gray, micaceous	5	560
Sandstone, gray, micaceous, and a few pieces of coal	5	565
Shale gray micaceous and bits of siderite. (Second sample with this abel)		
Shale, black, and coal, with a few pieces of white and dark imestone and pyrite	10	575
Shale, black, and a few pieces of coal	5	580
Sandstone, gray, some yellow limestone, and a little shale and pyrite	5	585
Sandstone, gray, micaceous, and a little shale	5	590
Shale, black	5	595
Missing	5	600
(Second sample with this label). Dark shale, a few pieces of yellow limestone and coal	5	605
Shale, gray, micaceous, and some coal	5	610
Shale, dark	5	615
Shale, gray, micaceous	5	620
Shale, gray, and yellow, slowly effervescing limestone. Bits of olive-green sandstone	5	625
Shale, dark gray	5	630
Shale, gray	10	640
Shale, gray, and some black shale	10	650
Shale, gray	5	655
Shale, gray, micaceous	5	660
Shale, gray sandy, micaceous, some gray micaceous shale, and a few pieces of pyrite	10	670
No sample	5	675
Shale, gray	5	680
Shale, gray, a little gray sandstone, and concretionary siderite	5	685
Shale, gray, micaceous, and a few pieces of concretionary siderite	5	690
Shale, gray, micaceous	5	695
Shale, dark	5	700
Shale, gray	5	705
Shale, gray, some imprints of leaves	5	710
Shale, gray, micaceous, and a little sandstone	5	715
Shale, gray	5	720
Shale, gray, and some siderite concretions	5	725
Shale, dark gray, and some siderite	5	730
Shale, gray	10	740
Shale, dark gray	5	745
Shale, dark gray, and some siderite	5	750
Shale, gray, sandy, and a few small pieces of white limestone	5	755
Shale, gray, sandy	5	760
Shale, dark	5	765
Shale, gray, micaceous	5	770
Shale, gray, sandy	5	775

Description of Strata	Thickness *Feet*	Depth *Feet*
Shale, gray, micaceous, sandy	5	780
Shale, gray, micaceous, some siderite and black sandy shale	5	785
Shale, gray, micaceous	5	790
Sandstone, gray, some coal, some white limestone, pyrites and siderite	5	795
Coal, some gray sandstone, some limestone, and siderite	5	800
Shale, gray, and fire clay, and small pieces of coal and siderite	5	805
Shale, black, and some coal	5	810
Shale, black, micaceous	5	815
Shale, gray, and coal, with some siderite and pyrite	5	820
Shale, gray, some coal, concretionary yellow limestone and white limestone. Pyrite also noted	5	825
Fire clay, concretions of siderite, white limestone, black limestone, and black shale	5	830
Clay shale, green, pure limestone. The shale is filled with spherules of siderite up to 12 mm. in diameter	10	840
Shale, green, filled with spherulitic siderite concretions, some sandy, pyritiferous shale and some fragments of limestone	5	845
Shale, green, much concretionary limestone. Some of the limestone is white and pure, some is in the form of black concretions with centers of calcite, some is a gray rock filled with spherules of siderite, and other small grains of siderite, while some is brownish red, and brecciated and contains organic fragments	5	850
Sandstone, white, some shale and a few fragments of limestone	5	855
Shale, gray, and shaly sand	5	860
Like the preceding	5	865
Shale, sandy, some black shale, and some coal	5	870
Sandstone, very micaceous, white	5	875
Shale, micaceous, sandy	5	880
Sandstone, gray, micaceous	5	885
Sand, shaly, gray	5	890
Like the preceding	5	895
Sand, gray, micaceous, with much pyrite, some of which is interestitial in the sand	5	900
Sand (sample very small)	5	905
Sandy, light gray, shaly rock	5	910
Like the preceding	5	915
Samples wanting	15	930
Shale, dark, stony, micaceous	5	935
Like the preceding	5	940
Sandstone, gray	5	945

Description of Strata	Thickness *Feet*	Depth *Feet*
Sand and black laminated stiff shale. **Sample marked: "Salt** water **in this** sand **or Bridge-port sand"**	10	960
Sand, coarse, rounded, with **brownish-black** grains **which effervesce** very **slowly** in **acid. Many crinoid stems were** noted, **which** did not **effervesce in acid, and which had the appearance of being siliceous**	15	975
Sand, **coarse, gray, mixed** with siderite **fragments, pyrite, and some fire** clay	5	980
Sandstone, **gray,** siderite, **and** fire clay	5	985
Sand, **gray,** fairly **clean,** showing secondary crystalline enlargements	5	990
Sand, gray, showing secondary enlargement of grains	10	1000
Sandstone, yellowish gray, micaceous	5	1005
Sand, gray, some limy material	5	1010
Sand, white, micaceous with some limy material	5	1015
Sand, white, micaceous	5	1020
Sand, coarse, white	5	1025
Sand, coarse, white, showing secondary enlargement of some grains	5	1030
Sand, gray, showing secondary enlargement of some grains	5	1035
Sand, coarse, gray (two samples)	5	1040
Sand, gray	5	1045
Sand, fine, gray, micaceous	10	1055
Sand, gray, some pieces showing lamination, some dark shale	5	1060
Sandstone, gray, some dark greenish, micaceous shale, pyrite present	5	1065
Sand, coarse, gray, some gray shale, a little coal, pyrite and concretionary limestone of obscurely spherulitic concretionary structure	5	1070
Shale, dark, some white sandstone, a little coal, and bits of siderite. Two samples	5	1075
Sandstone, white, concretionary siderite, some pyrite, and dark shale. A few red, conchoidally splitting fragments were noted which were hard and did not effervesce. This sample was labeled "dark sand" by the driller	5	1080
Fire clay, gray, of fine texture	20	1100
Shale, dark gray, fine in texture, and comparatively soft	10	1110
Shale, dark gray and black	5	1115
Shale, greenish, dark, micaceous	15	1130
Shale, greenish black, of fine texture	5	1135
Shale, dark, micaceous, stiff	10	1145
Shale, dark, with siderite concretions	5	1150
Shale, dark	5	1155

Description of Strata	Thickness *Feet*	Depth *Feet*
Shale, dark greenish, with a few minute and irridescent mica scales	20	1175
Shale, dark, gray fire clay, and coarse sand	5	1180
Sand, gray, showing secondary crystalline faces on some grains	5	1195
Shale, dark greenish, gray micaceous, speckled with minute, black fragments, probably carbonaceous	5	1200
Shale, gray, concretionary siderite	5	1205
Sandstone, gray, coarse, with a white siliceous interstitial cement, and some gray shale and siderite	5	1210
Shale, gray, concretionary siderite, with some small pieces of sandstone	10	1215
Shale, black, micaceous, some siderite	10	1220
Shale, gray, sandy, some sandy shale and a little black shale	5	1225
Shale, gray, micaceous	5	1230
Shale, gray, micaeous	5	1235
Shale, greenish gray, sandy, micaceous	5	1240
Mostly a brown, apparently fragmental siderite, having the texture of an organic breccia, with white, coarse sandstone and gray shale	5	1245
Siderite, fragmental and granular, white sandstone and gray shale	5	1250
Sandstone, white, and granular siderite	5	1255
Sand, laminated, white pure, with granular brown siderite	10	1265
Sandstone, yellowish gray, of fine texture	5	1270
Sand, yellowish gray, of fine texture, clean	5	1275
Shale, greenish black, of very fine texture	15	1290
Shale, greenish, dark, and fine sand	10	1300
Sandstone, white, with infiltrated matrix of partly calcareous material, and some shale. Driller's note "Sandy lime"	10	1310
Shale, dark, and white sandstone with infiltered lime. Driller's note: "Sandy lime"	10	1320
Shale, dark, and a little sandstone with infiltered lime, bits of pyrite	10	1330
Sand, white, somewhat coarse, and a little dark shale, Pennsylvanian in aspect. A carbonaceous film or shred was seen adhering to a small piece of sandstone	15	1345
Sand, yellow, with a few flakes of mica and some dark shale. Drillers note: "Salt sand." Pennsylvanian in aspect	15	1360
Mississippian strata--		
No sample	5	1365
Sand, yellow, and some gray oolitic limestone	5	1370
No sample	15	1385

Description of Strata	Thickness Feet	Depth Feet
Limestone, gray, oolitic. Drillers note: "Lime"....	10	1395
Limestone, gray, oolitic..........................	5	1400
Shale, gray, with a few bits of pyrite...........	10	1410
Shale, dark, and white sandstone with infiltered lime. Driller's note: "Sandy lime"...............	30	1440
Shale, black, and some white sandstone, with a little infiltered lime	5	1445
Shale, black, and some white sandstone with infiltered lime	5	1450
Shale, dark, some white limestone and red shale. Drillers note: "Sandy lime, and top or red rock for 30 feet past"........................	5	1455
Shale, gray, and organic, white fragmental limestone. In this limestone are pieces of *Fenestella, Polypora* (?), echinoid spines, flutes and tuberculated, some spicules (?) and fragments of brachipod shells, and crinoid stems. Some red shale noted.....................	5	1460
Like the preceding with echinoid spines............	5	1465
Limestone, organic, fragmental, and dark gray shale	10	1475
Shale, black, and organic, fragmental limestone....	10	1485
Limestone, organic, fragmental, and some green shale	5	1490
Limestone, organic, fragmental, and black shale. Some gray sandstone and an *Athyris* noted....	5	1495
Shale, dark. Some limestone and crinoid stems noted	5	1500
Shale, dark red, with some calcareous material......	5	1505
Shale, dark, green	5	1510
Shale, bluish black	5	1515
Shale, gray, and reddish-yellow shale with considerable calcareous material.................	10	1525
Shale, greenish black and brownish black, of fine texture	5	1530
Shale, brownish red, with a yellowish streak........	5	1535
Shale, brownish red, and dark, greenish-gray shale..	5	1540
Shale, brownish and greenish gray. Drillers note: "Red rock in all 1530 to 1547 feet"........	10	1550
Shale, greenish gray	10	1560
On the cover of this sample is written: "Top of lime 1560 feet. Cased here." The sample is a grayish-white shell breccia, which consists of small and thin shell fragments lying more or less flat in the same plane, showing small *Athyris* shells, and shells of other brachiopods, and crinoid stems....................		1560
Shale, greenish, sandy, or shaly sand, with some red shale and some white sandstone of fine texture. Brachiopod spines noted..........	10	1570

Description of Strata	Thickness *Feet*	Depth *Feet*
Sand, dark greenish, of fine texture with some white fine sand. Pyrite noted. On cover of sample is the note: "Top of Benoist or oil sand"	5	1575
Sand, dark, green, of very fine texture, with some shale of the same color. Pyrite, white sandstone, white limestone and spines and shells of brachiopods noted. Labeled: "Benoist sand"	5	1580
Sand, white, with grains of about ⅛ mm. in diameter. Drillers note: "Oil sand"	5	1585
Sand, greenish gray, and sandy shale, some of which shows incipient fissures along which oxidation has taken place, and the material has assumed a red color. Some of the shale is red. Crinoid stems and fragments of brachiopod shells noted. Sample marked: "Benoist or oil sand"	15	1600
Sandstone, siliceous, white, gray, and green, of very fine texture. Size of grains in this, as in previous two samples, about 1-16 mm. in diameter. Some dark gray, greenish gray, and red shale. Some sandy shale was noted with joints of oxidized, red material intersecting the green. This rock shows thin laminations	5	1605
Sandstone, greenish gray, and dark brown of very fine texture. This rock is laminated, showing quite intensely green layers alternating with gray, brown, and red layers. The laminae are from 1-16 to 1-2 mm. in thickness and more, and quite straight. On the cover of the sample is the note: "Bottom of oil or Benoist sand"	5	1610
Sand, light gray, slightly micaceous, and apparently slightly coarser than the preceding, some dark sandy shale, and some dark brown shale	5	1615
Sand, gray, coarser than the above and ground up into separate grains. These average about 1/6 mm. in diameter. On cover of sample is the note: "Salt water sand"	10	1625

Log of Kinmundy mine shaft

Location—Kinmundy, Illinois.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Drift clay	12	..	12	..
Sandstone and shale	134	5	146	5
Limestone, pebbly	1	4	147	9
"Slate", black	9	7	157	4
Coal	1	2	158	6
Fire clay	7	..	165	6

ption of Strata	Thickness Ft.	In.	Depth Ft.	In.
y	19	7	185	1
ack	11	..	196	1
	1	6	197	7
	2	..	199	7
	37	10	237	5
lack	5	..	242	5
bituminous	2	..	244	5
	..	6	244	11
and black shale	6	..	250	11
	..	2	251	1
	5	6	256	7
and black with bands of lime	51	..	307	7
ack	1	6	309	1
	1	..	310	..
	1	6	311	6
	3	..	314	6
y	15	9	330	3
ack	3	..	333	3
	2	..	333	5
	2	10	336	3
sandstone	65	6	401	9
	..	4	402	1
	4	..	406	1
	3	..	409	1
	71	..	480	1
	9	10	492	..
minous, and 2 inches coal	2	..	494	..
bly	5	..	499	..
and shale	76	..	575	..
pebbly	1	6	576	..
minous, and ½ inch coal	2	6	579	..
	5	..	584	..
and shale	69	..	653	..
k	..	10	653	10
	..	7	654	5
	2	..	656	5
sandstone and fire clay	8	6	664	11
	14	2	689	1
	21	6	710	7
	2	..	712	7
en	1	6	714	1
pebbly	6	..	720	1
and shale	84	2	804	3
	2		806	3
	11	..	817	3
and shale	30	..	847	3
} No. 6	2	2	849	5
k } No. 6	3	..	852	5
gray limestone } No. 6	4	..	856	5
} No. 6	4	2	860	7

Geologic Structure

The geologic structure is best known in the southwestern part of Marion County where most of the mines and oil wells are located. In other parts of the county the holes are scattered and data on the coals are so meagre that correlations of beds is difficult and the structure therefore uncertain.

Marion County lies a short distance west of the deepest part of the Illinois coal basin, and in a general way the dip of all the beds is eastward. The most pronounced feature is the northward extension of the Duquoin anticline along the western edge of the county as far as Sandoval, where its axis begins to plunge towards the northeast. The axis of the fold passes near Centralia and Sandoval. The anticline is symmetrical, having its steeper dip to the east.

The axis of the fold undulates, the higher areas possessing the characteristics of domes, as in secs. 29 and 31, T. 2 N., R. 1 E. and in sec. 8, T. 2 N., R. 1 E. These features possess more than ordinary interest because they have been responsible for oil and gas accumulation, the largest field being located on the dome north of Sandoval. A detailed report on the Marion County oil fields by R. S. Blatchley, was published in Bulletin 16 of the Illinois State Geological Survey. From the top of the dome at Sandoval, where coal No. 6 is 32 feet below sea level, the bed dips eastward to Salem at the rate of about 36 feet per mile, although the dip is not uniform throughout the distance of 9 miles. In fact, from sec. 9, T. 2 N., R. 1 E. to Odin, the coal lies practically flat.

In the southwest corner of the county, the coal shows a dip of 200 feet in 1½ miles, as indicated by its position in mine No. 5, Centralia Coal Company, sec. 25, T. 1 N., R. 1 W., Washington County, and in the drill hole, sec. 20, T. 1 N., R. 1 E. It is probable that faulting is responsible for some of the irregularities of structure along the anticline. In Marion Coal Company's mine, NW. ¼ NE. ¼, NE. ¼ sec. 21, T. 2 N., R. 1 E., a northeast-southwest fault of approximately 30 feet displacement having a downthrow to the west, was found 200 to 300 feet east of the shaft. More than usual interest is attached to this fault, since a small oil seep in the mine along the plane of fracture was responsible for the discovery of the Marion County oil fields. The latter feature is described more fully under the subject "Roof".

In mines 3 and 4 of the Centralia Coal Company in sec. 7, T. 1 N., R. 1 E. a fault, probably the southward continuation of the one mentioned above, shows a displacement of 110 feet, the coal being higher on the east side. The fault is located 1800 feet east of the shaft in mine No. 3, SW. ¼ NE.¼ sec. 7, and 1500 east of the shaft in No. 4

NW. ¼ SE. ¼ sec. 7, the direction of the fault being slightly east of south at this place. Its location south of Centralia is uncertain, but it is believed to lie east of mines No. 2 and No. 5, and it is entirely probable that the break is east of the Miller Oil Company's well, SW. ¼ NW. ¼ sec. 20, T. 1 N., R. 1 E. The fault has limited operations on the east side of the mines mentioned. The steep east dip in the southwest corner of the county is no doubt complicated by faulting, but no details can be predicted at present. Such a condition would be in harmony with the geologic structure farther southwest along the Duquoin anticline in Perry County.

The structure of eastern Marion County is uncertain. At Kinmundy coal No. 6 lies about 273 feet below sea level; but at Farina in T. 5 N., R. 4 E. the same bed is nearly 130 feet higher, although the latter hole is 6 miles northeast of the Kinmundy shaft and would be expected to reach the coal at a lower altitude if the regular east dip affected this area. Some uncertainty exists in this case since no written log was kept for the Farina hole.

In the extreme eastern part of the county, SE. cor. sec. 25, T. 3 N., R. 4 E., a 6-foot bed of coal overlain by limestone was found at a depth of 1050 feet, about 520 feet below sea level. Its correlation as coal No. 6 is strengthened by the existence of a thinner bed 89 feet lower, apparently No. 5. The east dip of 12 feet per mile from Salem to this hole, is regular for the district.

The 2-foot beds in sec. 4, T. 2 N., R. 4 E. and sec. 24, T. 2 N., R. 3 E. lying 273 and 350 feet below sea level are probably above coal No. 6 and the latter bed has not been recorded. Figure 19 shows the position of coal No. 6 along a line from Central City east through Salem to the edge of the county.

Coal No. 6

DISTRIBUTION AND THICKNESS

In Marion County coal No. 6 is best known in the southwestern part where it has been mined, and in the same region much information has been gained in drilling for oil and gas, although coal data secured in the latter operation are more or less unreliable. The Survey has no drill records for the following townships: T. 4 N., R. 4 E., T. 3 N., Rs. 2 and 3 E., T. 1 N., Rs. 2, 3, and 4 E. With the exception of Tps. 1, 2, and 3 N., R. 1 E., the holes are scattered, and the coal records were not carefully kept. It is believed that the bed is represented by at least a few feet of coal throughout the entire county; but predictions as to its commercial possibilities must necessarily be stated with caution, since such data as are available outside the prin

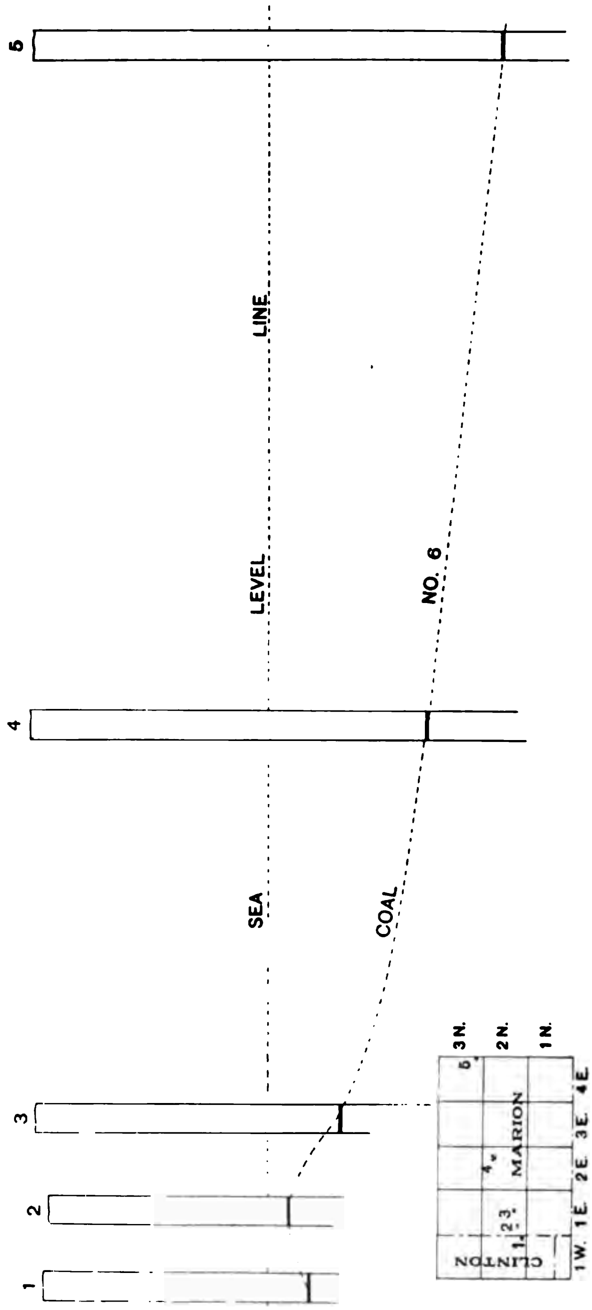

Fig. 19. —Sections showing position of coal No. 6 along a line from Central City to Salem, Marion County.

cipal mining area indicate that even where the bed is identifiable its thickness and general character are decidely variable. Mining was formerly done at Kinmundy and at Salem, but operations were abandoned because of abnormal conditions.

The average thickness of coal No. 6 from measured sections in the mines of Marion County is 6 feet, the range being from 5 feet 6 inches to about 6 feet 10 inches. At Kinmundy the bed is represented by two benches separated by 3 feet of shale underlain by 5 feet of limestone. The upper coal varies in thickness from 28 to 36 inches and the lower averages 43 inches. At Salem it is 4½ feet thick, and the mine was abandoned several years ago. In the future when the areas of thicker coal in the Centralia district are mined out, capital will be interested in the development of the eastern part of the county, and the thinner coal will be extracted. The Centralia district is surrounded by areas of thinner coal (see Pl. I). Tps. 1 and 2 N., R. 1 E., have the advantage of uniform thickness and quality of coal and good transportation facilities.

It is probable that other areas in the county contain coal of equal thickness and character, but careful work with the diamond drill will be necessary in order properly to outline them.

PHYSICAL CHARACTER

The coal in the Centralia area resembles that of the entire Belleville district, although its average thickness is 6 feet, or 1 foot less than the average for the district.

Figure 20 is a graphic representation of coal No. 6 from measurements made in some of the Marion County mines. The physical and chemical differences in coal No. 6 east and west of the Duquoin anticline, as shown further south, are not apparent in Marion County. As stated above, the anticline loses its identity north of Sandoval, and it is probable that general conditions were much the same on either side of the known fold during deposition of the coal.

In mine No. 5, Centralia Coal Company, the usual 3 benches are present, and the entire bed varies in thickness from 5 feet 4 inches to 8 feet, the average being about 6 feet. The top coal is irregular in thickness but persists throughout the mine. It consists mostly of glance coal which is extremely brittle and breaks into tarry, conchoidal pieces.

The prominent "blue band" 3 to 12 inches above the floor separates the middle from the bottom coal. The fracture of the middle and lower benches is blocky, and the bottom coal is the hardest of all. Gypsum and calcite are deposited in fracture planes in considerable

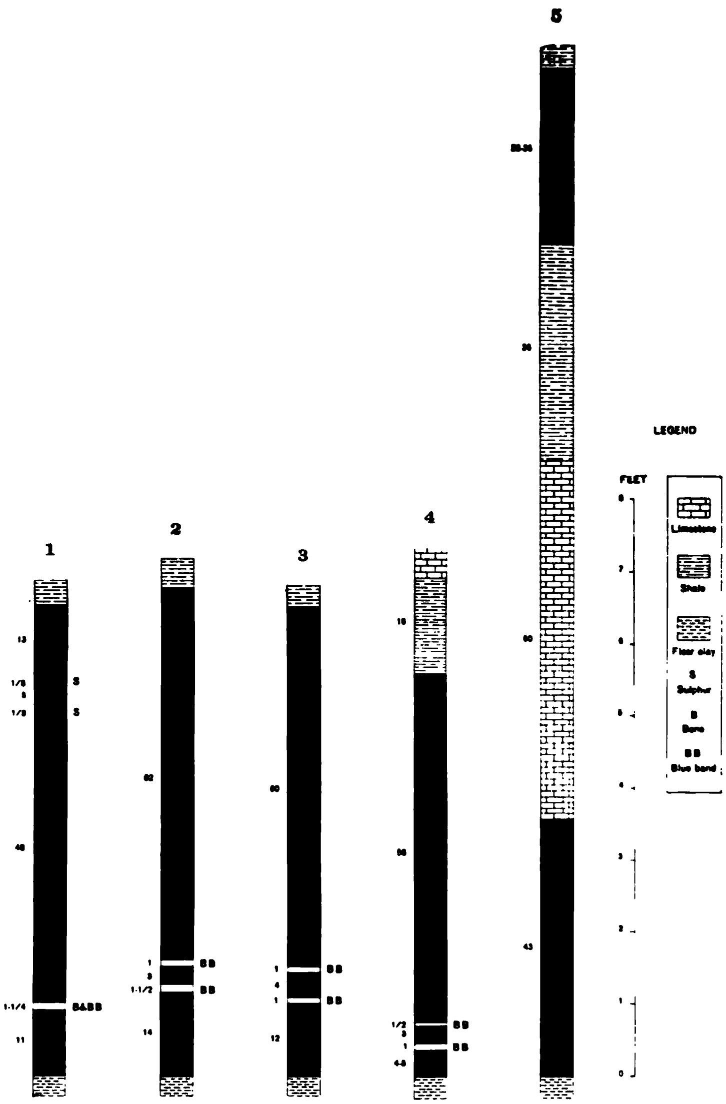

FIG. 20.—Graphic sections of coal No. 6 from measurements made in mines of Marion County.

1. Odin Coal Co., Odin. Room 1, 2nd. north, west entry.
2. Centralia Coal Co., No. 2, Centralia.
3. Centralia Coal Co., No. 4, Centralia.
4. Chicago Sandoval Coal Co., No. 2, Sandoval. Room 8 off 2nd. south on east side.
5. Kinmundy Coal Co., Kinmundy. (Abandoned.) Air course 300 feet southwest of shaft.

amount. Small bands of pyrite and dirt are noticeable, but the "blue band" is the only one persistent.

At Odin in the northeastern part of the Centralia field at the most easterly mine now operating in the county, the coal varies in thickness from 6 to 7 feet. The top coal averages 15 inches in thickness, and the bottom bench from 4½ to 8 inches.

The following section shows the average physical character of the bed at Odin:

Section of coal No. 6 in Odin Coal Company's mine, Odin

	Thickness	
	Ft.	*In.*
Top coal, clean, bright, laminated	..	16
Pyrite, persistent	..	¼
Coal, clean, finely laminated	..	5
Dirt and pyrite, persistent	..	¼
Coal, laminated, with many dirt bands, and considerable pyrite in lenticular streaks	4	..
"Blue band", gray shale, although in some places pyrite only	..	2
Coal dull	..	10
	6	10

The coal at Odin is very similar to that at Centralia. The gypsum and calcite in the fracture planes are conspicuously abundant. Fibrous ferrous sulphate is developed on the exposed ribs and on the floor, especially in the more moist places. At numerous places in the Odin mine calcareous clay veins cut the bed vertically. In most places they do not exceed 4 inches in width, and as a rule they extend only part way from the top to the floor. Moreover, there appears to be no system to the veins and no means of predicting their occurrence. They are interesting because of their rare development in coal No. 6, and their similarity to the veins in coal No. 5 at Springfield. At Odin they are not large enough to be especially troublesome in mining.

At Kinmundy two beds of coal 8 feet apart lie at the horizon of bed No. 6. In places the interval consists entirely of shale which forms a roof for the lower bed, and in others as much as 5 feet of limestone rests on the lower coal. It is believed that the two benches represent coal No. 6, and that the intervening material is simply a parting similar to that in coal No. 2 at Murphysboro. The top bench varies from 28 to 36 inches and the lower averages 45 inches. Mining has been confined mostly to the lower bench, although the upper bed is said to be the better coal and to have the stronger roof. This coal does not part readily from the roof and its variable thickness renders its commercial value uncertain.

Clay veins similar to those at Odin cut through both coals and the intervening beds. In the Centralia Coal Company's mines No. 2, No. 3, and No. 4 the "blue band" is in most places represented by two thin beds of shale separated by 3 or 4 inches of coal. The lower part of the band is the more persistent of the two.

ROOF AND FLOOR

The limestone cap rock is present over most of the county, and has an average thickness of about 15 feet. In places small shale partings are interbedded with the limestone. Below the cap rock the material overlying the coal is variable. At the Odin mine from 2 to 10 feet of black shale exists above the coal. In parts of the mine the lower 5 inches of this material is removed in mining. Above the shale the usual limestone cap rock is present over the entire mine.

Most of the records show a variable amount of clay under the coal. At the Odin mine the underclay reaches a thickness of 8 feet. It is very rocky and is unfit for commercial use. Ordinarily the clay is dry, but when the mine is idle the floor heaves sufficiently to cause inconvenience. The variability in character and thickness of the underclay of coal No. 6 make it extremely doubtful if any of it in Marion County can compete with the fire clay and shales near the coals in northern Illinois.

IRREGULARITIES

The feature of greatest importance as an irregularity in the county, so far as known, is the Centralia fault mentioned earlier in the report. North of Centralia in mines No. 3 and No. 4 the fault has a displacement of 110 feet, the upthrow being to the east. It is found 1800 feet east of the shaft in No. 3, and 1500 feet east of the shaft in No. 4, having at this point a slight northwest-southeast trend.

Two miles north in the Marion County Coal Company's mine in NW. ¼ NE. ¼ NE. ¼ sec. 31, T. 2 N., R. 1 E., a northeast-southwest fault having an upthrow of 30 feet to the east has been known for several years. The latter fault appears to be responsible for the oil seeps in the mine, which led to the discovery of the Marion County oil fields. At this place an oil sand exists only 17 feet below coal No. 6. The fault not only brings the sand into closer contact with the mine entries, but it also affords channels for the easy movement of oil particles. The relations between the coal and the oil sands are graphically shown in figure 21 which is adapted from figure 1, Bulletin 16 of this Survey.

In the Marion County Oil and Gas Company's well, SE. ¼ SW. ¼ sec. 29, T. 2 N., R. 1 E., about ½ mile east of the mine under con-

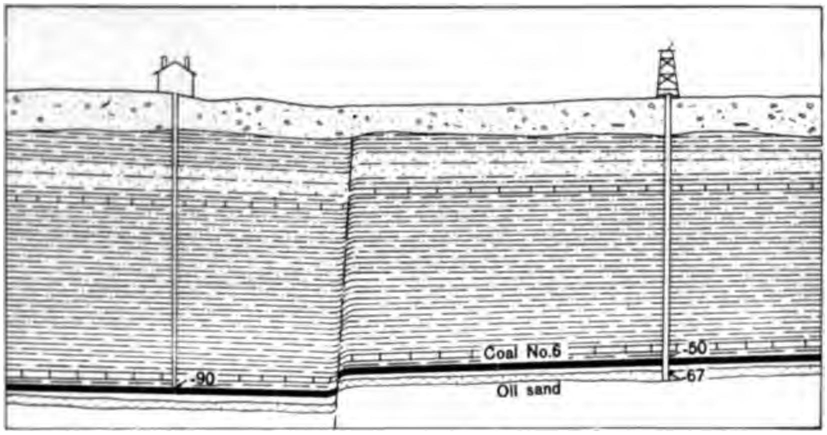

FIG. 21.—Sketch showing probable reason for oil seep in Central City mine. (After Blatchley.)

sideration, the coal and the oil sands were found at depths of 50 feet and 67 feet respectively below sea level. At the mine shaft the coal lies 600 feet below the surface or 90 feet below sea level. From the well westward to the fault, which is about 250 feet east of the shaft, the beds dip 23 feet, which is sufficient grade to allow the oil to gravitate down dip and seep into the mine. For several years this oil has been collected and used for lubricating purposes around the mine.

The direction and character of this fault, and its position along the axis of the Duquoin anticline lend strength to the belief that it is the northward continuation of the Centralia fault described above. The position of the coal in drill holes between Junction City and Centralia furnishes additional support to this belief.

OTHER COALS

Several coal horizons exist above coal No. 6, but all have proved to be commercially valueless under present conditions because they are lenticular, and most of them too thin for profitable mining.

From 35 to 50 feet above coal No. 6 there is commonly one bed, or in places two closely associated beds, which represent coal No. 7. Only one or two of the oil holes record this coal, and it is known chiefly in the shafts and in holes drilled for coal, of which there are but a small number. In the logs available for study, coal No. 7 ranges in thickness from 6 inches to 3 feet 4 inches. One record shows two beds separated by 10 feet of clay, the upper being 1 foot 4 inches and the lower 3 feet 2 inches in thickness. So far as known, no attempt has been made to mine this coal, and no information re-

garding its character is available. In mine No. 2, coal No. 8, 200 feet above No. 6, formerly marked the bottom of the shaft. The record shows that it was 7 feet thick, but if so, this is the only place in the State where coal No. 8 attains as great a thickness. The shaft was sunk later to coal No. 6, and no coal is now extracted from the upper bed. In other records thin beds of coal are reported near this horizon, but in no case is the thickness more than 14 inches. Many lenticular coals are reported in the shaft logs, but they are thin and can not be traced from one hole to another. None of these lenses exceeds 2 feet in thickness, and they can not be regarded as important in estimating the coal resources of the county.

Below coal No. 6 the beds are known only through oil-well logs which are unsatisfactory. Although many holes have been drilled in the county, the information regarding the lower coals is practically negligible. Only 7 records show coals below No. 6, although it is almost certain that other beds do exist. Two of these holes in sec. 4, T. 1 N., R. 1 E. penetrate coals said to be 5 feet thick. In one the interval between coal No. 6 and the recorded bed is 115 feet and in the other 220 feet. The latter coal occupies the position of coal No. 2, but data are too meagre to correlate it positively with the Murphysboro. The 5-foot coal, 115 feet below coal No. 6, is reported in but one hole, and it is believed that little confidence can be placed in the existence of any commercial bed at this horizon.

Coal No. 5, having a thickness varying from 5 to 7 feet, is reported in 4 holes near Odin and Sandoval. The bed lies from 25 to 45 feet below coal No. 6 in the western part of the county, but in sec. 25, T. 3 N., R. 4 E. at the eastern side the only bed referable to coal No. 5 is 85 feet below coal No. 6, showing a probable increase in the interval between the coals towards the east.

The large number of records and the paucity of coal data bring out forcibly the need of careful drilling and the correct determination of the position and thickness of coals even where oil is the major consideration. It is more economical to secure all possible data in one hole rather than to drill a separate hole for each kind of information. Despite the large amount of money expended, almost nothing is known regarding the areal distribution and thickness of coals below No. 6 in Marion County.

MONTGOMERY COUNTY

Production and Mines

Total production in tons, year ended June 30, 1913	2,418,329
Average annual production from 1908 to 1912	1,840,200
Total production, 1881 to 1913	16,902,790

During the year ended June 30, 1913, Montgomery County produced 3.89 per cent of the total output for Illinois. Only 10 mines were in operation, of which 6 produced more than 150,000 tons each. The county has increased steadily in its coal production, largely because of its advantageous location, good transportation facilities, and the improvement of its mining equipment.

Below is the list of mines operating in 1913. The Nokomis Coal Company has recently opened a new property at the place of the same name and with its modern equipment will add considerably to the total output for the county.

TABLE 9.—*List of shipping mines, Montgomery County, 1913*

Map No.	Company	Mine	Location ¼	¼	Sec.	T. N.	R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Peabody Coal Co.	14	SW	NW	32	10	2	665	576	89	8	..	551,772
2	Shoal Creek Coal Co.	1	SW	SE	22	7	4	537	374	163	7	..	542,473
3	Peabody Coal Co.	15	Cen.	NE	23	8	4	620	458	162	8	..	395,003
4	Hillsboro Coal Co.	Hillsboro	..	NE	12	8	4	620?	435	185?	7	..	351,723
5	Peabody Coal Co.	12	NW	SE	6	9	2	665	541	124	8	..	271,839
6	Peabody Coal Co.	11	NE	NW	5	8	3	651	462	189	7	6	167,070
7	Clover Leaf Coal Co.	2	SE	NE	3	7	3	630	517	113	7	6	85,516
8	Farmersville Coal Mining Co.	1	SW	NE	4	11	5	631	370	261	8	6	26,922
9	Litchfield Collieries Co. coal No. 2[3]	7	..	NE	32	9	5	690	702	12	4	8	20,593
10	Peabody Coal Co.	10	NW	NE	10	10	2	667	630	37	8	6	7,418
11	Nokomis Coal Co	..	SW	NW	28	10	2	663	658	5	7	6	......

COAL-BEARING ROCKS

Although an average thickness of 100 feet of drift covers the underlying rocks in Montgomery County except where streams have cut their valleys into the uppermost part of the coal-bearing forma-

[3]Litchfield coal lies near horizon of No. 2, but is not definitely correlated as No. 2.

tions, from a study of records of 115 coal and oil tests and mine shafts the stratigraphy is well known, especially down to, and including, coal No. 6. Unlike the holes in Marion County, the majority of which were drilled in search of oil, most of the Montgomery logs represent borings for coal and consequently careful attention has been given the Pennsylvanian beds.

In the western part of the county these rocks average about 750 feet in thickness, and the gradual eastern dip increases this thickness to about 1000 feet along the eastern boundary. Coal No. 6 varies in depth from 340 feet on the west to almost 700 feet near the east county line.

Next below the drift in the western half of the county is the Carlinville limestone which is exposed in places by the west fork of Shoal Creek. This limestone varies from about 270 feet to a little more than 300 feet above coal No. 6, the larger intervals appearing in the eastern part of the county. Its average thickness is about 10 feet, although greater thicknesses are reported, and in places it consists of two beds separated by a thin parting of shale. Its persistence in the logs is remarkable when one considers the large number of sources from which the records have been collected.

In Tps. 9 and 10 N., R. 1 W. and in T. 10 N., R. 2 W. the Carlinville limestone is 300 feet or more below the surface; and the New Haven limestone, ranging from 20 to 40 feet in thickness and lying about 200 feet above the Carlinville, forms the bed rock just as the latter underlies the drift in the western part of the county. In the southeastern townships the New Haven was eroded prior to the deposition of the glacial drift, and its line of outcrop, if drawn on the map, would extend parallel to and about 30 miles east of, that of the Carlinville.

The limestone cap rock over coal No. 6 is even more persistent than the coal itself. In fact, where the coal has been eroded, it is possible in many places to identify the horizon by the position of this roof limestone. Above the limestone, and separated from it by clay or shale, the drill generally penetrates coal No. 7 about 30 feet above coal No. 6. The higher bed is usually thin, but thicknesses of 2 feet are not uncommon. A short distance above coal No. 7 and usually less than 50 feet above coal No. 6, a thin bed of red or variegated shale is penetrated. Its colors are so pronounced that in spite of small quantity, drillers seldom fail to notice and record it.

Coal No. 8 is found over practically the entire county. It is from 150 to 180 feet above coal No. 6 and averages about 1 foot in thickness. The beds between coals No. 8 and No. 7 are mostly shales, and the same is true of those between coals No. 8 and No. 9,

which are 90 to 110 feet apart. Coal No. 9, where present, ranges in thickness from a few inches up to 1 or 2 feet. The interval between coal No. 9 and the Carlinville limestone above is composed largely of shales and does not exceed 50 feet.

The 200-foot shale interval between the Carlinville and the New Haven limestones is constant. Within this zone two thin coals 55 feet apart are reported in a number of holes, the upper bed being about 80 feet below the bottom of the New Haven limestone.

Below coal No. 6 there are from 300 to 350 feet of Pennsylvanian rocks and in this part of the section they are more sandy than in that part above the Belleville coal. A number of coals exist below coal No. 6 but they are so variable in thickness, character, and position that correlation is extremely difficult with present information. All of the commercial coals will probably be found in a zone not exceeding 250 feet, the top of which is formed by coal No. 6. The individual beds thus far known will be treated under "Other Coals" in this chapter.

The coal-bearing rocks lie on an ancient erosion surface of considerable relief, consequently the base of the Pennsylvanian is extremely uneven. Besides, the "Coal Measures" were deposited on two different formations in Montgomery county. West of a general northeast-southwest line extending from the southwest corner of the county, these overlie the St. Louis limestone known to the driller as the "Big Lime." East of this line beds representing the Chester group are interposed between the "Coal Measures" and the "Big Lime". In the Smith well, sec. 15, T. 7 N., R. 5 W., the Chester is only about 50 feet thick but it probably thickens towards the south and east, where it contains the oil sands of Carlyle, Sandoval, and the main fields of Illinois. The Chester is characterized by red or pink shales, thin limestones, and sandstones interbedded, and the top of the formation can usually be placed at the first limestone or red shale 250 to 300 feet below coal No. 6, and drilling for coal should be discontinued at this point. In the northwestern part of the county several hundred feet of solid Mississippian limestone underlie the coal rocks, and no coal exists below the top of this formation.

In 1886 a number of wells were drilled into the Pottsville formation near Litchfield, and both oil and gas were found. For a number of years the gas was used for lighting purposes, but the pressure decreased and it was abandoned. Oil was pumped until about 1904 and sold for lubricating purposes. The field is similar in size and character to that of Carlinville which is now producing oil and some gas commercially. The sandy nature of the beds forming the base of the "Coal Measures" renders them fit reservoirs for oil and gas where the geological structure is favorable.

The following log of a drill hole in sec. 24, T. 12 N., R. 5 W records all of the beds in the "Coal Measures" from the Carlinvill limestone down to the base of the formation which overlies the St Louis limestone. Coal No. 6 was reached at 342 feet, and the 3-foc coal at 397 probably represents coal No. 5. The 4½-foot bed is 571 together with the thinner bed 7 feet 9 inches below is probably to b correlated with coal No. 2 (Murphysboro). The base of the coal bearing rocks is found at 763 feet.

Record of George Hirsh well No. 5

Location—SE. cor. NE.¼ sec. 24, T. 12 N., R. 5 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Dirt	4	..	4	..
Clay	12	..	16	..
Sand and pebbles	10	..	26	..
Clay	9	..	35	..
Sand and pebbles	15	..	50	..
Limestone	11	..	61	..
Shale, dark	2	..	63	..
Shale, gray	13	..	76	..
Limestone, gritty (Carlinville)	10	..	86	..
Shale, black	4	..	90	..
Shale, gray	88	..	178	..
Shale containing sand and mica	8	..	186	..
Shale, gray	9	..	195	..
Limestone, gritty	9	..	204	..
Shale, gray	71	..	275	..
Sandstone, hard	6	..	281	..
Shale, dark	1	..	282	..
Shale, gray	5	..	287	..
Shale, red	6	..	293	..
Shale, gray	16	..	309	..
Shale	3	..	312	..
Shale, gray	4	..	316	..
Stone, hard	4	..	320	..
Stone, gray	4	..	324	6
Limestone	5	8	330	2
Shale, argillaceous	..	8	330	10
Limestone	..	3	331	1
Shale, argillaceous	1	5	332	6
Limestone	..	5	332	11
Shale, argillaceous	1	7	334	6
Sandstone	3	4	337	10
Shale, argillaceous	..	10	338	8
Limestone	2	..	340	8
Shale, black	1	8	342	4
Coal (No. 6)	8	6	350	10
Shale, gray	3	..	353	10

Description of Strata		Thickness		Depth	
		Ft.	*In.*	*Ft.*	*In.*
Shale, white		1	2	355	..
Limestone		4	..	359	..
Shale, white		2	..	361	..
Limestone		2	8	363	8
Shale, argillaceous		6	7	370	3
Shale, gritty		3	9	374	..
Clay, blue		13	..	387	6
Shale, black		9	6	397	..
Coal (No. 5)		3	..	400	.
Shale, argillaceous		1	6	401	6
Limestone		..	9	402	3
Shale, argillaceous		6	3	408	6
Shale		1	..	409	6
Coal		..	1	409	7
Clay, blue, gritty		40	5	450	.
Shale, blue		13	3	463	3
Shale, black		2	6	465	9
Coal		2	9	468	6
Shale, argillaceous		5	4	473	10
Coal		..	6	474	4
Shale, gritty		17	8	492	..
Soap-clay		5	..	497	..
Shale, black		1	4	498	4
Coal		1	6	499	10
Shale, argillaceous		6	2	506	..
Shale, gray		7	..	513	.
Shale, black		8	6	521	6
Coal		..	6	522	6
Shale, argillaceous		2	10	524	10
Limestone		1	3	526	1
Shale, argillaceous		..	11	527	.
Coal		1	6	528	6
Shale, white, argillaceous		5	6	534	9
Shale, gritty		3	.	537	
Shale, argillaceous		1	1	538	1
Shale, dark		2		540	1
Shale, calcareous		1	11	542	4
Shale, argillaceous		5	6	547	6
Clay, blue		18	6	566	.
Shale, black		5	3	571	3
Coal		4	6	575	9
Sandstone		6	6	582	3
Coal	No. 2	..	4	582	7
Shale, black	No. 2	.	11	583	6
Coal	No. 2	2	6	586	10
Shale, black		2	4	588	4
Shale, gritty, and sandstone		21	2	609	6
Sandstone, argillaceous		16	6	626	
Shale-clay		2	.	628	

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sandstone, argillaceous	4	..	632	..
Shale, argillaceous	15	6	647	6
Shale, black	3	6	651	..
Pyrites	..	8	651	8
Clay, black	1	4	653	..
Sandstone	24	..	677	..
Shale, gritty, and sandstone	6	..	683	..
Sandstone, argillaceous	5	..	688	..
Sandstone	2	..	690	..
Sandstone, argillaceous	1	..	691	..
Shale, black	2	..	693	..
Sandstone, argillaceous	9	..	702	..
Shale, black	16	..	718	..
Sandstone	..	6	718	6
Shale, black	2	6	721	..
Limestone	4	..	725	..
Shale, black	5	..	730	..
Sandstone containing lime	9	..	739	..
Shale, black	3	4	743	..
Shale, blue	9	8	751	..
Sandstone	3	2	753	..
Shale, gritty	7	10	763	..
Lime, gritty	6	10	773	..
Sandstone	..	10	783	..
Lime, gritty	..	20	803	..

Record of Singer well, Peabody Coal Co.

Location—sec. 4, T. 10 N., R. 2 W.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Soil and clay	2	..	2	..
Soil and clay	8	..	10	..
Sand and gravel	20	..	30	..
Clay, tough, blue	19	..	49	..
Gravel, coarse	2	..	51	..
Limestone, hard, broken	6	..	57	..
Limestone (New Haven)	28	6	85	6
Sand shale	10	6	96	..
Sand shale with blue shale partings	16	..	112	..
Sand shale	19	..	131	..
Shale, light blue	28	..	159	..
Shale, blue	10	..	169	..
Shale, black	1	..	170	..
Coal	..	4	170	4
Shale, dark	4	8	175	..
Shale, gray	1	..	176	..
Sandstone with blue shale partings	4	..	180	..
Shale, light blue, and sandstone	5	..	185	..

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Shale, light blue	9	..	194	..
Shale, gray	2	..	196	..
Shale, dark	2	..	198	..
Shale, light blue	17	7	215	7
Sand shale	10	6	226	1
Shale, black	1	6	227	7
Coal	..	8	228	3
Shale	3	..	231	3
Lime shale	1	9	233	..
Lime shale with limestone bands	5	..	238	..
Sandstone	1	..	239	..
Shale, light blue, with sand shale partings	25	..	264	..
Shale, light blue	14	6	278	6
Sand shale	7	6	286	..
Shale, blue, with sand bands	6	..	292	..
Shale, gray	2	6	294	6
Lime shale with nodules	2	..	296	6
Clay shale, dark	3	6	300	..
Lime shale with limestone bands	6	..	306	..
Clay shale, dark, with limestone bands	3	..	309	..
Limestone (Carlinville)	14	..	323	..
Shale, black	2	8	325	8
Coal	..	2	325	10
Clay shale	3	2	329	..
Clay shale, dark	1	6	330	6
Sandstone with blue shale partings	2	6	333	..
Shale, light blue, with sandstone partings	9	..	342	..
Shale, light blue	5	..	347	..
Shale, blue	13	..	360	..
Sandstone	13	..	373	..
Sandstone, dark	12	..	385	..
Shale, blue	..	6	385	6
Limestone	1	2	386	8
Shale, black	6	4	393	..
Coal	..	6	393	6
Shale, dark blue	3	6	397	..
Slate, light blue	3	8	400	.
Shale, dark blue	4	4	405	..
Sand shale	5	..	410	.
Shale, blue, with sandstone partings	38	..	448	
hale, blue, with hard bands	18	..	466	.
hale, blue, with sandstone partings	9	8	475	8
ndstone	1	.	476	8
ale, tough, blue	4	4	481	..
ale, blue	1	10	482	10
l	1	1	483	11
e clay	1	9	485	8
dstone	13	4	503	..
d shale	22	..	525	.

Description of Strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Shale, dark blue	72	5	597	5
Sandstone	13	10	611	3
Shale, blue	2	9	614	..
Limestone	4	2	618	2
Shale, blue and red	2	10	621	..
Shale, black	2	..	623	..
Shale, blue	1	..	624	..
Shale, dark blue	4	5	628	5
Coal (No. 7)	2	..	630	5
Shale, dark blue	8	3	638	8
Lime shale	3	..	641	8
Limestone	2	4	644	..
Shale, blue	3	..	647	..
Limestone	8	..	655	..
Slate, black	2	10	657	10
Coal (No. 6)	6	5	664	3
Sand, blue (No. 6)	..	1	664	4
Coal (No. 6)	1	8	666	..
Fire clay	1	..	667	..

Geologic Structure

In common with the rocks of adjoining areas, the underlying formations of Montgomery county have a general eastern dip. Along the western part of the county coal No. 6 lies from 250 to 300 feet above sea level; whereas along the eastern side the same bed is at sea level, showing a dip of slightly more than 10 feet per mile across the county. This dip is not uniform, however, and slight folds or even reversals of the dip are known in a few localities.

The principal structural features in Montgomery county are the Hillsboro flat or terrace, the Sorento dome and the Ohlman anticline, all of which are described in an earlier part of this bulletin. The relation of the structure to oil and gas accumulation is treated in detail in Bulletin No. 28 by R. S. Blatchley.

Local dips affecting small areas are found in some of the mines, but the general structure is too gentle to have much effect on mining conditions. Faults are infrequent and when present generally do not affect the coal more than the thickness of the bed. One such fault in the Panama mine of the Shoal Creek Coal Company is illustrated in figure 22. It is a north-south fracture about 2500 feet west of shaft and has been traced 1000 feet.

The erosion channels which are well known in the county will be discussed under the subject "Distribution and thickness". These channels are known to the miner as "faults" but since the coal is ab-

sent because of erosion rather than by reason of fracturing and displacement, the term "fault" is not applicable.

Coal No. 6

DISTRIBUTION AND THICKNESS

The main areas of coal No. 6 in Montgomery County are (1) the narrow portion at the northwest corner projecting northward between Christian and Macoupin counties, and (2) that part east of a northeast-southwest line roughly parallel to and a few miles west of the C. C. C. & St. L. R. R. Between these two areas is another of irregular size and shape in which coal No. 6 is either thin or absent. The existence of the latter area has been known for several years, but hitherto no attempt has been made to outline it except in the most general manner. The lines on the large map indicate its boundaries as closely as they may be drawn with available information. Revision will be necessary from time to time, but the general shape and position of the area is believed to be represented correctly. So far as

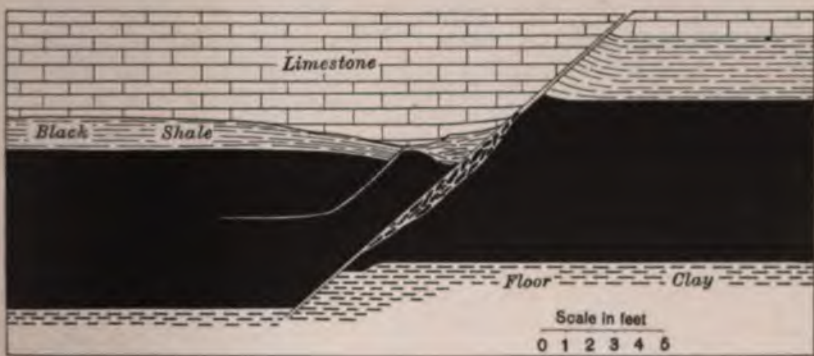

Fig. 22.—Fault in Panama mine of Shoal Creek Coal Co. 1st W., north entry, 2500 feet from shaft.

known it comprises parts or all of the following townships: T. 7 N., R. 5 W.; T. 8 N., Rs. 3, 4, and 5 W.; and T. 10 N., Rs. 2, 3, 4, and 5 W. It is not known whether the absence of the coal is due to lack of deposition or to erosion after deposition. At many places inside the area the bed is represented by a few inches, and in a very limited number of places, by its normal thickness. In the latter case, other holes nearby penetrate only a small amount of coal.

The presence of so variable an amount of coal indicates either that most of the area stood higher than the surrounding swamp during Pennsylvanian time, and the coal was deposited only in pockets, or

that later a large drainage line with its tributaries occupied the area and removed most of the coal. Here and there coal No. 6 is absent, but its limestone cap rock has not been affected; however, many other logs show the absence of both coal and limestone, sandstone being present at the usual position of these beds. Such a condition seems clearly to indicate erosion after the deposition of the roof materials.

It is possible and even probable that mineable areas of coal No. 6 will be found inside the boundaries indicated on the map, but the location of such lands will be the result of the most careful diamond drilling and by the placing of holes less than ¼ mile apart. If, as is believed to be the case, an ancient drainage system occupied this part of the county, its tributary streams eroded the coal so that its present boundary is represented by an extremely irregular line which can be known accurately only after much more mining and drilling have been done. In this connection it is probable that the absence of the coal in places near Carlinville, Macoupin County, is the result of the same erosive processes that operated in Montgomery County, and it is also probable that the two areas are directly connected.

On the east side of the barren zone the best-known tributary is a channel 1000 feet wide extending slightly east of south from the main area west of Hillsboro through the east side of mine 15, Peabody Coal Company, Taylor Springs, and probably southward at least to sec. 12, T. 7 N., R. 4 W. The coal was found at about the same level on both sides of the channel, there being no displacement of the beds. However, this feature is known to the miner as a "fault" a term which he uses for any absence of the coal. On the east side of the channel almost one mile southeast of the shaft, coal No. 6 in normal thickness lies only 20 feet lower than at the shaft. The western edge of the channel was reached in the 5th and 6th east stub entries off the 3rd northeast, and thus far it has been the practice to abandon the entries upon reaching the channel. By drilling three or four holes along a line extending in an east-west direction the Montgomery County Coal Company, previous owners of the mine found the channel to be about 1800 feet wide.

The east side of the same erosion channel was probably reached in the northwest workings of mine No. 1, Hillsboro Coal Company, NE. ¼ sec. 12, T. 8 N., R. 4 W. From this point it is said to extend N. 35° E., but this direction appears to indicate only a minor bend in the course of the old stream since drill holes to the north indicate practically a normal thickness of coal. It is believed that the channel extends west from the Hillsboro mine and joins the main erosion area as indicated on the map.

Within the large "pockety" area shown on the map, most of the les show no coal at the horizon of coal No. 6. Others record from few inches to almost 4 feet. One hole drilled by the Wilmington tar Coal Company, SW. ¼ SW. ¼ sec. 2, T. 7 N., R. 5 W., reached feet of coal; another drilled close to the first by the same company netrated only 6 feet of coal, but the measurement is not regarded re-ible. The general area in which the existence of the coal is uncer-in is well known to the majority of operators, and doubtless many ars will elapse before any large amount of drilling will be done here the chance of locating a commercial acreage is slight.

In the mines of Montgomery County, coal No. 6 ranges in thick-ess from 6 feet to a little more than 9 feet, the average being 7 feet inches. In that part of the county including T. 11 and 12 N., Rs. 4 nd 5 W., the same bed averages 8 feet, and it is being mined only at armersville.

East of the barren area the county is underlain by uniformly thick al, most of which has been untouched by mining operations. Forty-

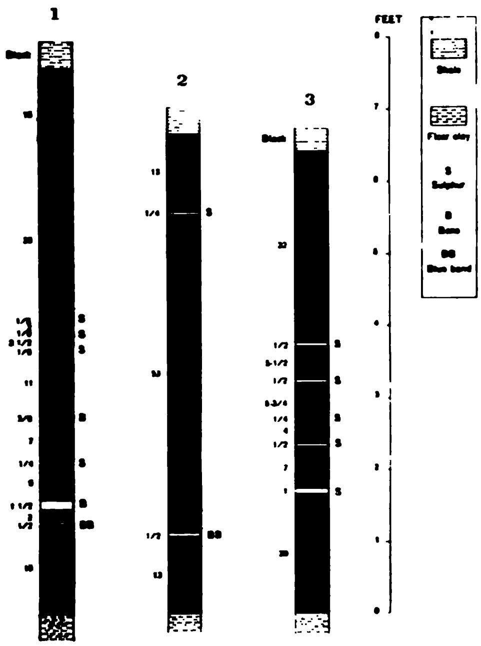

Fig. 23.—Graphic sections of coal No. 6 from measurements made in mines f Montgomery Co.

1. Shoal Creek Coal Co., No. 1, Panama. Room 1, 1st. south stub off 8th est, south entry.

2. Peabody Coal Co., No. 15, Taylor Springs. Entry face, 2nd. stub west f angle.

3. Hillsboro Coal Co., No. 1, Hillsboro. Room 36, 6th W. off main north.

six drill holes distributed over the area show an average thickness of 7½ feet for coal No. 6, a thickness which is about 6 inches greater than the average for the entire district covered by this report.

PHYSICAL CHARACTER

As seen at the face in the mines, the coal does not differ materially from that adjoining counties. Figure 23 shows the physical character of the coal. The three benches persist, the top coal attaining a thickness of 18 inches in a few places. It is not left for roof as regularly as in the Franklin-Williamson district, but at Panama it is not removed where black shale overlies the coal, as it does in about one-half of the mine. At the Hillsboro Coal Company's mine No. 1 about 10 inches of top coal is left to protect the shale which does not make a good roof.

The coal is banded with pyrite, dirt, and charcoal, and its luster is in most places dull, although glance coal is harder than the higher is in most places dull, although glance coal is present in small layers. Ordinarily the bottom coal is harder than the higher benches, and in many places it is comparatively free from impurities.

The following section was measured in mine No. 1, Shoal Creek Mining Company at Panama, and is typical of the bed in other mines of this county.

Section of coal No. 6 measured in mine No. 1, Shoal Creek Coal Mining Company, Panama

	Thickness	
	Ft.	*In.*
Top coal	..	14
Pyrite streak	..	..
Coal, clean and hard	..	7
Charcoal and sulphur	..	1⅝
Coal, clean	..	2¾
Charcoal	..	1
Coal, fairly clean	1	1
Dirt band	..	¼
Coal dull	..	4¼
Dirt	..	¼
Coal, dull with bright coal bands	..	2
Dirt	..	¼
Coal, dull and bright laminated	..	3⅝
Sulphur	..	⅛
Coal, clean	..	5¾
Dirt	..	⅛
Coal, dirty	..	3¾
Sulphur	..	⅛
Coal, dirty	..	5

	Thickness Ft.	In.
Sulphur	..	½
Coal, very dull and dirty	1	
"Blue band", shale, and black jack	..	3½
Coal, clean and hard, streaks of charcoal	1	1¾
	—	—
	7	⅛

ROOF AND FLOOR

Outside of the barren area described earlier in this chapter the cap rock of coal No. 6 is the usual limestone. At Panama throughout half of the mine limestone directly overlies the coal. Throughout the remainder of the mine is an intervening black shale which falls if exposed to the air. In order to protect this shale 10 to 14 inches of top coal is left in place. Otherwise the shale falls to the cap rock about 3 feet above. In Dering mine No. 22 at Witt, about 18 inches of poorly bedded, calcareous shale underlies the cap rock in places; whereas elsewhere in the mine black shale as great as 5 feet in thickness occupies this position. At mine No. 1, Hillsboro Coal Company, the so-called "white clod" attains a thickness of 5 feet in places; whereas the black shale is generally less than 2 feet thick.

Figure 24 illustrates roof conditions in mine No. 1, Nokomis Coal Company, at Nokomis according to Mr. C. W. Smith, Mining Engineer for the company. On account of the heavy slates it was the original intention to drive wide entries and allow everything below the upper limestone to fall. Where work was begun, conditions were as shown in No. 1, but farther along the entry a thin bed of dirty coal was found in place of the carbonaceous shale and it became necessary to narrow the entries and to hold up all of the roof materials on account of the danger of mine fires. As shown in figure 25 the black shale probably grades laterally into coal. Whether it exists in small areas or over most of the mine depends on conditions at the time of deposition and can not be predicted.

The limestone varies greatly, different reports assigning to it thicknesses between 1 and 15 feet. However, variable as it is, its strength is sufficiently great to provide an efficient roof. Most of the trouble experienced is the result of the inconstant character and the lack of cohesion exhibited by the materials between the limestone and the coal. Where it is convenient to leave the top coal in place it serves to protect the shales, and its own strength is sufficient to require much less timbering than do the shales, if the top coal is removed.

As has been mentioned in the chapter on Macoupin County tl the limestone was eroded in the eastern part of the county by the sa agencies that removed both limestone and coal further east along t

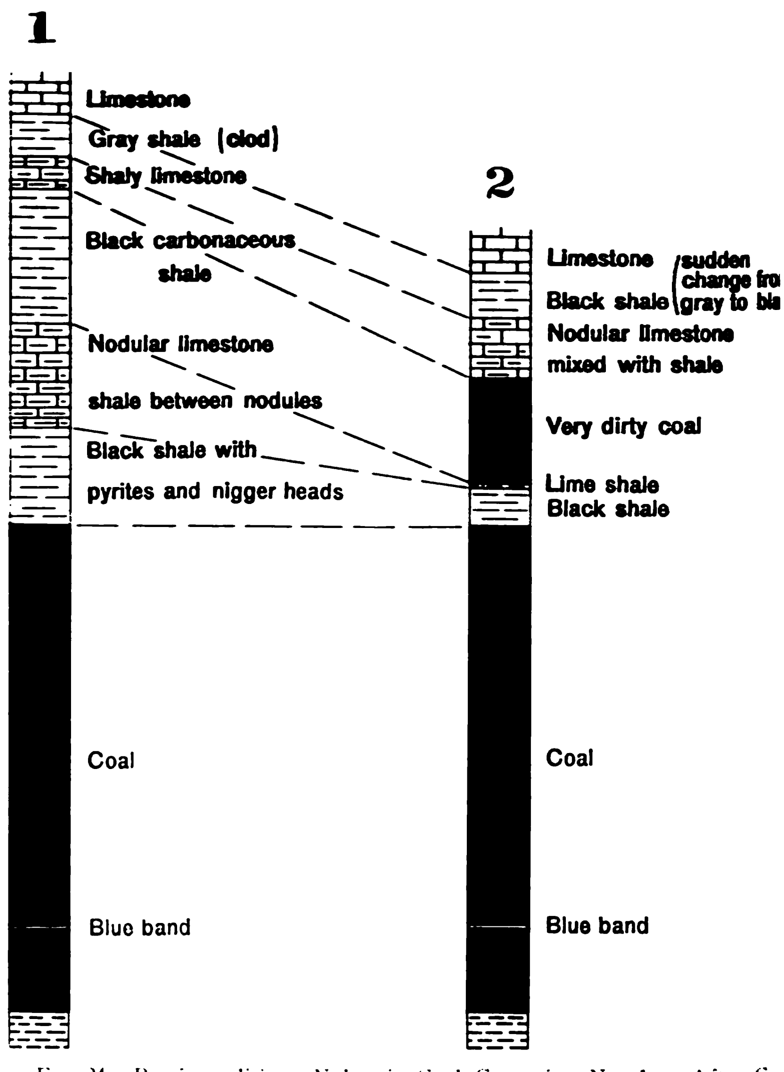

FIG. 24.—Roof conditions Nokomis Coal Co., mine No. 1. (After C. Smith.)

Montgomery County line, it is to be expected that near the old dra age area roof conditions will be uncertain.

In places both the limestone and black shale contain concretic known as "niggerheads," which project downward into the coal a

tend to fall when the latter is removed. The concretions in the limestone are probably siliceous; whereas those in the shale are composed of lime carbonate. However, the black shale only rarely shows the presence of lime.

Clay of variable thickness and character underlies the coal. At Panama a fairly constant thickness of 14 feet is reported. It is gray, sandy, and very hard when fresh, but slakes and heaves readily on exposure to the air and especially where water is present. Near the bottom of the clay, lime bowlders are common, and below these is a poorly bedded, impure limestone. In other mines of the county the underclay is reported to be variable, ranging in thickness from 18 inches to as much as 12 feet, but its character is not favorable to commercial development.

IRREGULARITIES IN ROOF AND FLOOR

Attention has been called to the chief irregularity in roof coal and floor in the county, namely, the ancient drainage channel. Up to the present time their effect has been known chiefly in the mines immediately south and southwest of Hillsboro. Small channels a few hundred feet wide can be crossed by entries at no great cost, but if a shaft happens to be placed near the edge of a large channel, the area of mining operations is limited to one side of the eroded area. It is probable that future mines located near the edges of the barren area will discover tributary channels of different sizes, the existence of which can not be ascertained from present drill holes.

The real faults in the mines are insignificant. They are minor fractures along which slight movement has occurred, but the displacement does not ordinarily exceed the thickness of the coal.

OTHER COALS

The only coal of commercial importance above coal No. 6 is coal No. 7 which lies about 30 feet higher. Coal No. 7 is generally thin, but in T. 10 N., Rs. 1 and 2 W. most of the holes indicate a thickening which is apparently local. A number of drillers report from 2 feet to 2 feet 9 inches for the bed, and in sec. 36 a thickness of 3 feet 2 inches is recorded, although the latter is from a churn-drill record and is somewhat uncertain.

The only coal utilized in the county besides coal No. 6 is a bed averaging 4 feet 8 inches in thickness about 240 feet below coal No. 6 and mined by the Litchfield Coal Company, NE. ¼ sec. 23, T. 9 N., R. 5 W. The bed is in the proper position to be correlated with coal No. 2 (Murphysboro), although it may be slightly older. David White regards it distinctly Pottsville in age which would place it be-

low coal No. 2. Definite correlation must be postponed until more deep drilling is done. This is the only mine located in the area from which coal No. 6 has been eroded, and it was necessary to operate the best lower bed. The coal lies 690 feet below the surface at the mine and dips 3 degrees northwest and away from the anticline or the arching of the beds which was probably responsible for the oil and gas accumulation southeast of Litchfield. The coal is in one bench and varies from 26 inches to a maximum of 84 inches. It is streaked with layers of pyrite generally not exceeding ¼ inch thick, but larger amounts are not unknown. Its chemical analysis is not unlike that for coal No. 6, and its dissimilarity to the typical Murphysboro coal renders its correlation with that bed doubtful. The roof consists of "clod", poorly bedded calcareous shale, or gray shale; the former attains a thickness of 3 feet, and at least 10 feet of the latter appears in parts of the mine. Above both of these materials is a limestone from 1 to 5 feet thick. The contact of the roof with the coal is uneven, the rolls here and there extending down within 2 feet from the floor. At a depth of 704 feet, the same coal 4 feet 10 inches thick is reported in a drill hole in the SE. cor. NE. ¼ sec. 29, T. 9 N., R. 5 W., and the Felpers well drilled by the Producers Oil Company in the SW. ¼ sec. 29, T. 8 N., R. 5 W. passed through a similar bed 4 feet thick at 575 feet.

Three other coal horizons are reported between coals No. 2 (?) and No. 6. From 25 to 50 feet below coal No. 6 a number of the deeper holes show a coal which ranges in thickness from 8 inches to 3 feet and probably represents coal No. 5. From 30 to 60 feet lower, another horizon is prominent, especially in holes drilled in T. 9 N., R. 5 W. At this horizon the coal consists either of a single bed 3 or 4 feet thick or of two benches separated by a few feet of shale. The upper is said to vary from 2 feet 4 inches to 3 feet 8 inches in thickness. In the same township, 40 or 50 feet below the beds last mentioned, are several thin beds separated by small partings of shale, the group being about 100 feet above the horizon of coal No. 2. Since the various coals enumerated above are reported from drill holes in a small area, and the intervals between the beds are so variable, definite correlations are impossible. It is at least encouraging to know that, although coal No. 6 is absent over a large area in Montgomery County, other beds of possible commercial value exist lower in the coal-bearing rocks, and it is still more encouraging to know that at Litchfield one of these lower beds has been, and is being, mined. Such deep drilling as has been done indicates that sometime in the future, when most of coal No. 6 is mined, further tests will be made of the thickness and character of the coals within the 250-foot zone below

coal No. 6. It will be necessary to use the core drill in order to make careful studies of the physical and chemical character of the various beds.

ST. CLAIR COUNTY

Production and Mines

Production in tons for year ended June 30, 1913... 4,740,212
Production in tons, 1908 to 1913................21,621,533
Total production, 1881 to 1913..................77,532,658

During the year ended June 30, 1913, St. Clair County produced 7.6 per cent of the State's entire output. The position of the county with respect to the large markets of the St. Louis region, has been a most important factor in keeping St. Clair in the front rank of coal producers. As late as 1911, this county was first in rank, a place it has occupied seven different times between 1881 and 1912. During 1912-1913, it ranked fifth owing to large increases in Williamson, Sangamon, Franklin, and Macoupin counties.

Of the 65 mines operating, only 10 produced more than 100,000 tons each. Fifteen local mines were responsible for 102,660 tons of the total production.

Below is the list of mines shipping in 1913.

TABLE 10.—*List of shipping mines, St. Clair County, 1913*

Map No.	Company	Mine	Location ¼	¼	Sec.	T.	R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	St. Louis & O'Fallon Coal Co.	2	..	cen.	33	2N	8	560	199	361	6	2	713,381
2	Consolidated Coal Co.	17	SE	NW	10	2N	8	584	230	354	6	6	615,318
3	Prairie Coal Co.	..	..	SW	27	2N	8	583	205	378	7	..	420,363
4	Southern Coal, Coke & Mining Co.	8	SW	NE	17	1N	7	475	113	362	7	..	391,316
5	Southern Coal, Coke & Mining Co.	7	NW	SW	18	1N	7	525	131	394	8	..	283,079
6	Jos. Taylor Coal Co.	St. Ellen	NE	NW	26	2N	8	563	205	358	7	..	203,389
7	St. Louis & O'Fallon Coal Co.	1	SW	NE	32	2N	8	510	127	383	6	..	153,461
8	Superior Coal Min'g. Co.	..	NW	SW	1	1N	9	580	153	427	7	..	138,369
9	Kolb Coal Co.	2	cen.	NW	32	1N	6	420	153	267	7	..	124,031
10	Suburban Coal & Mining Co.	..	..	SE	35	2N	9	580	168	412	7	..	121,137
11	Kolb Coal Co.	1	NW	SE	32	1N	6	420	160	260	7	..	98,886
12	Kolb Coal Co.	Fairbank	SE	NE	2	3S	7	449	90	359	6	..	85,672
13	Breese-Trenton Mining Co.	..	SE	NE	25	2N	6	514	335	179	4	6	84,357
14	Mulberry Hill Coal Co.	1	SW	SW	7	1S	7	520	143	377	7	6	81,298
15	Star Coal Co.	Star	SW	SE	30	1S	7	498	83	415	6	8	76,714
16	Joseph Taylor Coal Co.	Taylor	SE	SW	24	2N	8	555	200	355	7	..	74,096
17	Jones Bros. Coal Co.	Eureka No. 1	NW	SE	27	3S	6	450	114	336	6	6	63,853
	Eldnar Coal Co.	..	..	..	..	..	..	..	105	..	6	..	57,296

TABLE 10. *Continued*

Map No.	Company	Mine	Location ¼	Location ¼	Location Sec.	Location T.	Location R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	Average thickness In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
19	**Borders Coal Co.**	No. 1	NE	SW	27	3S	6	450	98	352	6	9	53,744
20	Summit Coal Mining Co.	Summit	..	SW	9	1N	8	560	176	384	7	..	52,795
21	Jos. Taylor Coal Co.	Ridge Prairie	SE	SW	26	2N	8	567	203	364	8	.	51,328
22	Johnson Coal Co.	O. K.	NW	NW	35	3S	6	450	118	332	7	..	49,210
23	White Coal Co.	Miller	NW	SW	15	1N	8	515	113	402	7	..	48,146
24	Pittsburg Mining Co.	..	..	SW	16	1N	8	550	123	427	6	6	43,306
25	Oakdale Coal Mng. Co.	Glendale	SW	SW	23	1N	8	520	114	406	6	4	42,900
26	Fullerton Coal Co.	Fullerton	NW	NE	16	1N	8	550	153	397	..	..	42,593
27	Groome Coal Co.	Richland	NW	SW	1	1S	8	503	83	420	7	..	37,585
28	Gauch Coal & Mining Co.	Enterprise	SW	NW	34	1N	7	450	93	357	7	3	31,500
29	Missouri & Illinois Coal Co.	Rentchler	SE	NE	33	1N	7	470	107	363	7	..	30,845
30	Maule Coal Co.	Harmony	..	NE	12	1N	9	583	173	410	7	..	29,400
31	International Coal & Mining Co.	Carbon	cen.	NW	25	2N	8	560	194	366	6	..	28,237
	L. Senior	..	..	..	..	..	..	..	70	..	6	7	27,169
33	Highland Coal Co.	..	NE	SE	22	1N	8	535	133	402	7	..	25,864
34	New Nat'l Coal Co.	National	..	NE	33	1N	8	470	74	396	6	6	25,250
	Southern Coal, Coke & Mining Co.	Avery No. 1	..	..	..	..	..	..	183	..	6	6	22,554

TABLE 10.—*Concluded*

Map No.	Company	Mine	Location ¼	¼	Sec.	T.	R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
36	Tirrie Coal Co.	..	NW	SW	7	3S	6	440	93	347	7	..	21,595
	Kolb Coal Co.	Valley	..	..	..	..	..	..	85	..	7	..	20,464
38	Cluley Miller Coal Co.	Ruby	NE	SW	21	2N	8	560	173	387	6	..	20,409
39	St. Clair Coal Co.	St. Clair	NW	NW	18	1S	7	524	122	402	6	6	19,323
40	Vulcan Coal & Mining Co.	Hippard	SE	SE	34	1N	8	489	93	395	6	6	18,675
41	Golden Rule Coal Co.	..	SW	SE	1	3S	7	422	47	375	6	6	17,334
42	Egyptian Coal & Mining Co.	Meek No. 2	NE	SW	36	3S	6	517	183	334	6	..	16,080
43	Fischer Coal Co.	..	SE	SE	12	1S	9	547	18	529	..	..	15,200
44	Silver Creek Valley Coal Co.	..	..	SW	35	1N	7	470	84	386	6	..	13,961
45	Mulberry Hill Coal Co.	2	NW	NE	19	1S	7	519	143	376	7	6	11,800
	Reeb Bros. Coal Co.	Murphy	..	..	..	..	..	..	40	..	6	..	11,507
47	Missouri & Illinois Coal Co.	Wilderman	..	Cen	1	1S	8	503	93	410	6	6	8,295
48	Southern Coal, Coke & Mining Co.	5	NE	NW	20	1N	8	543	112	431	6	..	8,294
49	Egyptian Coal & Mining Co.	Advance	NE	NE	28	3S	6	450	97	353	6	6	5,585
50	Kolb Coal Co.	Vinegar Hill	NE	NW	2	3S	7	448	82	366	6	6	561

For a detailed report on mining practices in this county the reader is referred to S. O. Andros: Ill. Coal Mining Investigation, Bull. 4.

Coal-bearing Rocks

The coal-bearing beds cover approximately the eastern three quarters of St. Clair County. The line of outcrop of the basal beds extends north and south about 3 miles west of Millstadt, is parallel to, and a short distance west of, the Mississippi bluffs from a point 2 miles southwest of Centerville to Alton, and leaves the county about 7 miles northwest of the latter city. The outcrop line is obscured by glacial drift, which varies in thickness from 50 to 150 feet; and the underlying rocks are exposed only where streams have removed the surface deposits. West of the line of outcrop of the "Coal Measures", the Mississippian group constitutes the bed-rock of the county, and the same beds underlie the "Coal Measures" in the eastern part of St. Clair. The coal-bearing rocks consist of shales, sandstones, and a minor amount of limestone; whereas the Mississippian beds are largely limestone and interbedded shales and sands.

Immediately beneath the coal-bearing beds is a group of formations called the Chester which consists of red shales, sandstones, and limestones interbedded. In a general way this group thickens eastward where as much as 600 feet are known in drill records. Its most conspicuous feature is the red shale which lies at different horizons throughout the group, and in drilling the Chester may be recognized as soon as one of these shales is penetrated. These beds are not to be confused with the thin pink to red shale noted in many places about 50 feet above coal No. 6. The Chester contains the oil sands at Carlyle, about 18 miles east of the St. Clair-Clinton county line, a detailed report of which by E. W. Shaw was published by the Illinois State Geological Survey in Extracts from Bulletin 20.

The following log by the P. H. Postel Milling Company at Mascoutah represents the deepest boring in the county, and indicates the nature of the beds underlying the area covered in the report.

Record of P. H. Postel Milling Co., well No. 1

Location—sec. 32, T. 1 N., R. 6 W.

Description of Strata	Thickness Feet	Depth Feet
Loess	30	30
Quicksand	5	35
Sand, white	5	40
Sand, gravel and other drift	64	104
Limestone	8	112
Shale, hard, coaly	30	142
Limestone	3	145

Description of Strata	Thickness Feet	Depth Feet
Coal (No. 6)	6	151
Shale	15	166
"Soapstone"	10	176
Shale	25	201
Coal (No. 5)	5	206
Shale, white	50	256
Shale, blue	40	296
Shale, white	45	341
Red rock	45	386
Shale	35	421
Shale "cave"	113	544
Limestone	5	549
Sandstone	45	584
Shale	25	609
Limestone	20	629
Red rock, probably a hard, calcareous shale	55	684
Shale, white	20	704
Sandstone (Benoist sand of driller?)	20	724
Limestone	460	1184
"Shale rock"	420	1604
Limestone, shaly	390	1994
Marl, red	70	2064
Limestone	126	2190
"Shale rock"	127	2317
Limestone	449	2766
"Shale rock"	58	2824
Limestone	10	2834
Shale and limestone	54	2888
Sandstone and some shale	219	3107

Coal No. 6, otherwise known as the Belleville coal, noted in the foregoing record at 145 feet, outcrops in the bluffs of the Mississippi, and because of its thickness and accessibility, it was among the first coals to be mined in the State. With the other beds it dips eastward at the rate of about 12½ feet per mile, and at Belleville it is reached by shafts at an average depth of about 100 feet, or 400 feet above sea level. The east dip continues to be effective towards Mascoutah, but because the surface of the ground also slopes eastward, the coal bed is only slightly more than 150 feet deep at Mascoutah. The deepest mine is located in the NE. cor. sec. 25, T. 1 N., R. 6 W., and is operated by the Breese-Trenton Mining Company. In it the coal is 345 feet below the surface.

Since 100 to 150 feet of glacial drift exists, only a small amount of the Pennsylvanian above coal No. 6 is present. It consists of shale and a few thin beds of limestone, the most important of which overlies the coal and forms its cap rock. Above the roof limestone there *are generally from* 10 to 20 feet of calcareous and sandy shales, which

are overlain by a limestone of variable thickness, but exhibit more regular bedding than the layer above the coal.

In southwestern Madison County and in parts of St. Clair coal No. 7 is found beneath the upper limestone, but according to Worthen, shale occupies this horizon at Belleville. The other limestones in the "Coal Measures" are more or less local in development and can not be traced over large areas.

Below the Belleville coal, the Pennsylvanian beds are extremely variable in thickness and character. At Millstadt coal No. 6 lies only 25 feet above the Chester beds, whereas at Marissa about 300 feet of "Coal Measures" rocks underlie this bed, data which show the irregularity of the surface upon which the coal-bearing rocks were deposited. Sandy beds are more prevalent in the lower portion of this series, but they can not be correlated from one hole to another.

Below is the log of a hole at Marissa, in sec. 27, T. 3 S., R. 6 W. Coal No. 6 lies at a depth of 88 feet, and the top of the Chester is found at a depth of 304 feet.

Drill record of Consolidated Coal Co.

Location—SE.¼ NW.¼ sec. 27, T. 3 S., R. 6 W.

Description of Strata	Thickness *Feet*	Depth *Feet*
Soil	44	44
Shale	6	50
Coal	2	52
Rock and shale	36	88
Coal (No. 6)	6	94
Fire clay	10	104
Limestone, blue	6	110
Shale, white	17	127
Shale, white, or sandstone	24	151
Shale, black	8	159
Fire clay	4	163
Shale	58	221
Shale, black	7	228
Coal	1½	229½
Clay, hard, gray	7	236
Coal	4	240
Fire clay	8	248
Sandstone, white, (salt water)	14	262
Fire clay	20	282
Sandstone	10	292
Fire clay	12	304
Limestone	29	333
Shale, blue	71	404
Limestone rock	50	454
"Soapstone", red	15	469
Limestone	48	517

Description of Strata	Thickness Feet	Depth Feet
Shale	4	521
Limestone	27	548
"Soapstone"	10	558
"Soapstone"	10	568
Limestone, very hard	27	595
"Soapstone"	13	608
Sand, white, (salt water and oil)	23	631
Limestone, dark, gray, very porous (gas)	33	664
Shale	10	674
Limestone	20	694
Shale	4	698
"Soapstone", red	3	701
Limestone	22	723
"Soapstone", red	11	734
Limestone rock	25	759
Clay, red	25	784
Sandstone, dark	4	788
Clay, red	10	798
Shale	1	799

Geologic Structure

The geologic structure has been determined from the position of coal No. 6 in outcrops, mine shafts, and drill holes. The bed outcrops in the bluffs of the Mississippi at an elevation of about 470 feet and dips eastward at an average rate of 15 feet per mile. The dip is not uniform over all the county but is modified by small folds, the most important of which are known as the Belleville-O'Fallon and the Darmstadt anticlines. As described earlier in this bulletin, the axis of the former fold extends from a point about a mile east of Belleville slightly east of north, passes about ½ mile west of O'Fallon, continues northeast about 2 miles, and loses its identity in that direction. The top of the fold is relatively flat and broad, and the dips so gentle that they are scarcely noticeable in mining. Just north of Belleville the anticline is almost 5 miles wide.

The Darmstadt anticline has been described by E. W. Shaw of the U. S. Geological Survey in Bulletin 20, Ill. State Geological Survey. The detailed description of the fold is quoted from Mr. Shaw in Part I of the present report. The fold is highest near Darmstadt where the coal lies 297 feet above sea level and dips north, west, and east, but its position to the south is unknown. It is probable that the fold extends northeast at least to the high area at Venedy, also described by Mr. Shaw.

At the southeast corner of the county in sec. 35, T. 3 S., R. 6 W. *the coal stands* higher than to the northeast or southeast. Its exten-

sion towards the southwest and northeast is unknown, but Mr. Shaw regards the high area in sec. 35 as a part of the White Oak anticline. Further drilling will be necessary in order correctly to describe its limits. Except for fracture planes along which there has been slight movement, the mines are free from faults. Local sags and hills are not infrequently found, but thus far, they do not appear to be part of any system of well-developed folds. Such irregularities are described fully under subject, "Roof and Floor".

Coal No. 6

DISTRIBUTION AND THICKNESS

Coal No. 6 underlies approximately the eastern three-fourths of St. Clair County. Its actual outcrop line is obscured by glacial drift except along the bluffs of the Mississippi where it has been mined by slopes for many years. The outcrop enters the north side of the county in the eastern part of sec. 6, T. 2 N., R. 8 W., runs southwest along the bluffs to sec. 7, T. 1. N., R. 9. W., thence southeast to the center of sec. 1, T. 1 S., R. 9 W., from which point it swings westward around Millstadt, and then in a general southeast direction to the south boundary line, which it crosses at the southwest corner sec. 33, T. 3 S., R. 6 W. South of the point at which it leaves the bluffs, its position has been determined from drill holes and mines, and although the line as shown on the map may require revision as later information becomes available, it is believed to be very nearly correct. East of this line the county is probably underlain by a solid bed of coal of commercial thickness. Detailed measurements have been made by survey men in 51 mines located in St. Clair County, and the average thickness obtained for coal No. 6 is 6 feet 9 inches, the individual measurements ranging from 5 feet to 8 feet. The same bed in 28 drill holes shows an average of 6½ feet, but since most of the holes were made by the churn drill, less confidence is placed in the latter figures than in the actual mine measurements.

The proximity of so valuable a coal to the surface near the outcrop has stimulated mining by stripping methods. In the vicinity of Millstadt a considerable area is underlain by coal No. 6, the overburden being less than 35 feet, and the combination of these favorable conditions with large markets nearby has by steam-shovel stripping developed a production that reached 15,200 tons in 1913.

The mines of the county are located near the outcrop and along the Baltimore and Ohio and the Louisville and Nashville railroads, which run east and west through the northern half of the county.

FIG. 25.—Stripping mine, Fischer Fuel Co., Millstadt (Photo by Fischer Fuel Co.)

FIG. 26.—Fischer Fuel Co., stripping mine, Millstadt, showing method of removing overburden. (Photo by Fischer Fuel Co.)

PHYSICAL CHARACTER

Coal No. 6 exhibits its usual three benches, but the top coal is seldom left for roof.

Figure 27 shows the physical character of the coal in some of the mines of St. Clair County. According to Worthen the top coal was mined separately in former years and was sold as blacksmith coal at 2

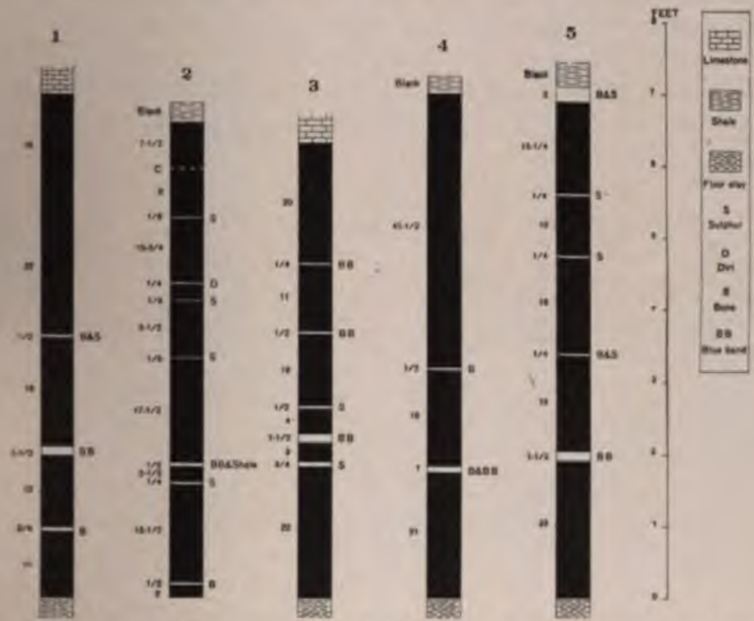

FIG. 27.—Graphic sections of coal No. 6 from measurements made in St. Clair County.

1. Joseph Taylor Coal Co., Taylor mine, O'Fallon. Face 4th. N. off E.
2. St. Louis and O'Fallon Coal Co., No. 2, French Village. Face main south.
3. Superior Coal and Mining Co., Superior mine, Ogle. Face main north, 3200 feet from shaft.
4. Southern Coal, Coke and Mining Co., No. 8, Shiloh. Room 8, 6th. south, west entry.
5. Borders Coal Co., Borders mine, Marissa. Room 8, 6th. E. off N.

cents per bushel more than that from the lower part of the bed. It varies in thickness from one foot to about 24 inches, and in most places it is the purest coal in the bed. At Lebanon the top coal is thinner and consists largely of "bone," which is discarded with an overlying 4-inch "draw slate." The condition is probably local and affects only a small area.

The middle bench which constitutes the largest part of the bed, is usually a somewhat duller coal and contains numerous streaks of dirt,

pyrite, and charcoal. The "blue band" is a persistent impurity 1 or 2 inches thick and consists chiefly of gray or black shale and some pyrite. In a few places it exists in two streaks separated by an inch or two of coal.

The bottom coal ranging in thickness from 12 to 24 inches or more is variable in character, its quality depending upon the amount of dirt disseminated throughout the coal mass. In places the bottom coal is scarcely more than a carbonaceous shale, but in others it has about the same quality as the middle bench.

Flakes of gypsum and calcite fill many of the cleavage planes and in some of the mines are very conspicuous at the face of the coal.

ROOF AND FLOOR

In this county the usual materials above coal No. 6 are black shale and limestone, the former existing as lenses between the cap rock and the coal. Both kinds of roof are extremely variable in thickness. Even in the same mine the shale may range from an inch to 6 or 8 feet.

In the Shiloh mine of the Southern Coal and Mining Company the black shale is present over part of the mine and reaches a thickness of 3 feet. It is laminated and full of seams or small fracture planes that extend into the overlying limestone. It is blocky and falls in masses which break into cubes. Nodules of limestone and siderite are found in the shale, and clod lies between the shale and the limestone. The latter is a dark-gray, compact stone about 12 feet thick, showing distinct bedding into benches which the miner calls "lifts". Between the bedding planes there is here and there a thin layer of shale as a parting. Small "slip" planes exist in the limestone, as well as in the shale, and displacements of 5 or 6 inches are not uncommon; the roof, therefore, has a tendency to break easily, aided as it is by the water which finds its way to the channel afforded by the slips. In the Taylor mine at O'Fallon there is no shale roof on the east side and but little on the west, but where present it contains many small slips and is difficult to hold in place.

The limestone roof is bedded, and the two lowest benches tend to fall easily. The first ledge, 2 to 6 inches thick, generally drops as soon as the props are removed. The second ledge falls only occasionally, and the main body of the cap rock, which forms an efficient roof, is reported to be about 12 feet thick. Its thickness over the county is extremely variable but averages a little less than 10 feet. Where the limestone overlies the coal the contact is usually uneven, and the irregularities are filled with clod which tends to fall easily. As a whole, the roof conditions are very similar to those of Madison County

which are described and illustrated from photographs in the chapter on the county. Figure 28 shows the relation of the limestone to the shale over a fracture in the coal at the St. Louis and O'Fallon Coal Company's Cameron mine.

As a rule the floor clay in St. Clair County is thin, many of the mines reporting only 1 or 2 feet of this material. In some places it is absent and the coal rests on an impure limestone of marine origin, which here and there according to Worthen contains an abundance of fossils.

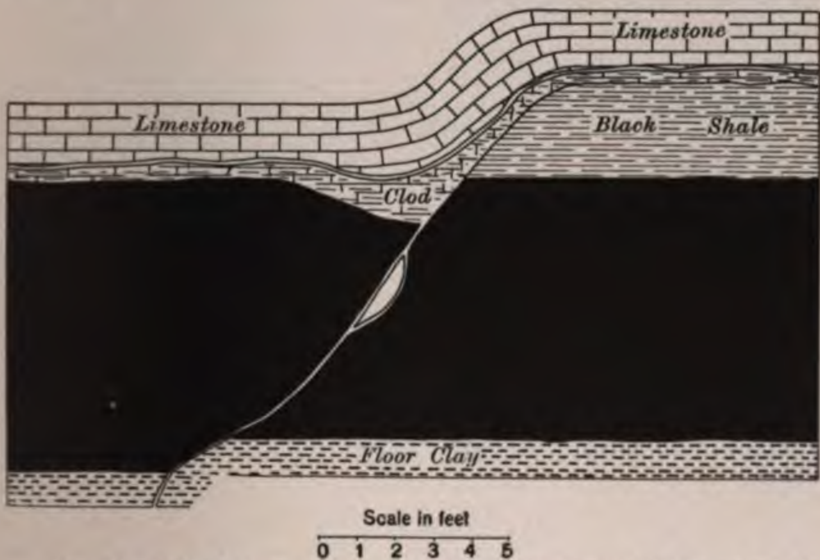

FIG. 28.—Fold in limestone above fault. St. Louis and O'Fallon Coal Co., Cameron. (Main south entry, 700 feet from shaft.)

At Shiloh, a typical mine, the floor is a dark-gray clay. The upper 18 inches is fairly soft, and the lower part contains bowlders which vary greatly in size. It heaves especially when wet. At the time of examination in an abandoned entry places were seen where the floor had heaved as much as 3 feet, and the pillars had been pressed down to the underlying limestone. The nature of the clay and its variable thickness do not lend strength to the belief that it might be valuable commercially. A few samples collected in the district are now being tested with others from different parts of the State, and a report will be issued as a separate bulletin later.

IRREGULARITIES IN ROOF AND FLOOR

The county is remarkably free from major disturbances in coal, roof, and floor. The small irregularities accompanied the adjust-

ments incidental to the settling of the coal and the overburden. The shale and the limestone, and in places the coal, show minor slip planes or slickensides that tend to cause roof weakness. In many places these slips are not discernible before the fall takes place, and for this reason, they are most dangerous. Figure 29 shows the nature of a fracture plane which has been filled with clay. In no mine has the displacement of the bed been sufficiently large to affect seriously mining methods.

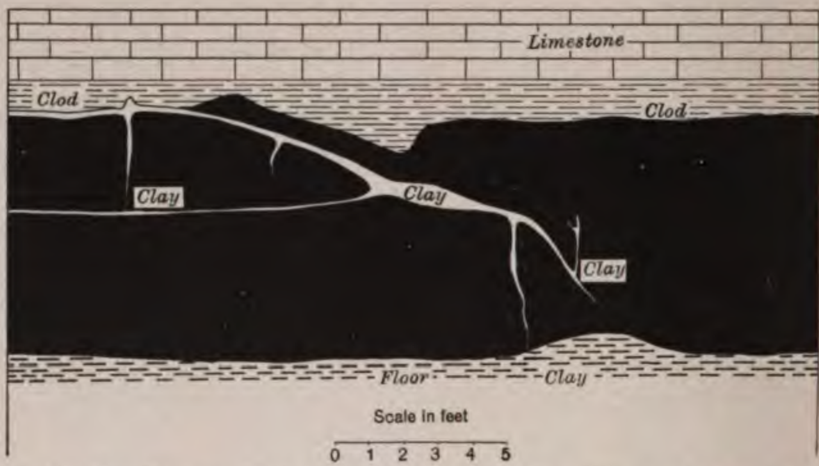

FIG. 29.—Fracture filled with clay. Southern Coal, Coke and Mining Co., Shiloh. (Main west entry.)

OTHER COALS

Very little is known regarding the existence of coals below No. 6 in this county. Worthen reports a 3-foot coal below No. 6 in the river bluffs at the old Pittsburg mines, 1 mile north of Centerville station. It is overlain by bituminous shale and 3 feet of impure, brown limestone, and probably represents coal No. 5. The same bed 5 feet thick is reported at the Postel well in Mascoutah where it is 50 feet below coal No. 6.

St. Clair County lies near the west edge of the coal basin, and it is probable that the coals below No. 6 are very irregular. The surface upon which the Pennsylvanian rocks were deposited was very uneven, and in western St. Clair county, there are places at which the interval between coal No. 6 and the Chester beds below is only 20 or 30 feet. Figure 30 is an ideal sketch showing the relation of the coal-bearing strata to the old land surface. In the vicinity of Marissa two holes penetrated a coal below the horizon of coal No. 5, although the latter is not present. In sec. 21, T. 3 S., R. 6 W. a 2-foot coal lies 110

feet below the Belleville bed, and in sec. 27 of the same township a 4-foot coal lies 148 feet below coal No. 6. It is overlain by 7 feet of hard, gray clay or shale, above which is an 18-inch bed of coal. No other logs in the county record these beds, and any attempt at correlation would be futile.

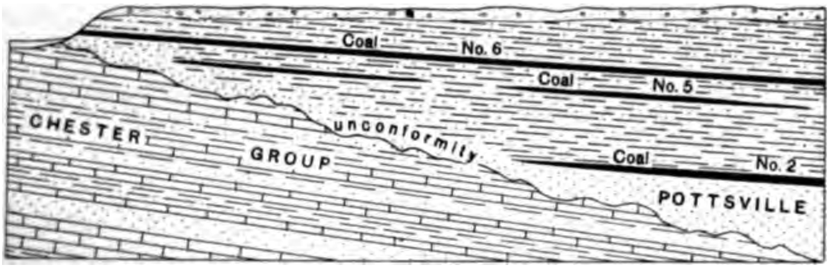

Fig. 30.—Sketch showing relation of "Coal Measures" to ancient erosion surface, St. Clair County.

It is probable that future exploration will disclose commercial coals below coal No. 6, but the minable areas will undoubtedly be small and disconnected. Test holes for the lower coals should be continued to a depth of 250 feet below coal No. 6, but if limestones and red shales are penetrated before reaching this depth, further drilling will be useless because the underlying Chester beds will have been reached.

PERRY, RANDOLPH, AND WASHINGTON COUNTIES

Production and Mines

PERRY COUNTY

Production in tons for year ended June 30, 1913..	1,634,043
Average annual production, 1908 to 1913........	1,506,365
Total production, 1881 to 1913.................	26,918,284

RANDOLPH COUNTY

Production in tons for year ended June 30, 1913..	712,058
Average annual production, 1908 to 1912........	977,039
Total production, 1881 to 1913.................	13,618,584

WASHINGTON COUNTY

Production in tons, year ended June 30, 1913.....	246,932
Average annual production, 1908 to 1912........	100,949
Total production, 1881 to 1913..................	1,829,468

Perry County has long been an important coal producer. During 1912-1913 its output equaled 2.6 per cent of that of the entire State. In considering Perry County as a unit, the writer treats also that part of the county east of the Duquoin anticline which is really closely associated with Franklin and Williamson counties in District VI of the Investigations. In his bulletin on mining practice Mr. S. O. Andros has separated the mines on the basis of their location east or west of the fold; but in this record of coal resources it is almost impossible to locate the axis definitely, especially north of Duquoin, and it is believed that the advantage of setting down the information for the entire county more than offsets the disadvantage of the slight overlap.

In 1913 twenty-three mines were operating, well distributed over the county except in the north central part which lacks railroad facilities. All are working coal No. 6 by shafts except two near Duquoin where the proximity of the coal to the surface has made strip mining possible. Below is given the list of shipping mines in Perry County in 1913.

TABLE 11. *List of shipping mines Perry County, 1913*

Map No.	Company	Mine	Location ¼	Location ⅛	Location Sec.	Location T.S.	Location R.W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	Average thickness In.	Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	**Security Coal Mining Co.**	1	..	SW	29	5	1	436	90	346	8	..	275,674
2	**Willis Coal Mining Co.**	1	NW	NW	30	6	4	503	80	203	6	..	244,538
3	**Paradise Coal Co.**	Paradise	NW	NE	15	6	1	409	371	38	10	..	241,483
4	**Majestic Coal & Coke Co.**	1	..	NW	23	6	1	402	403	-1	9	..	215,730
5	**Ritchey Coal Co.**	1	..	NW	23	5	3	460	140	320	7	..	158,852
6	**Duquoin Operating Co.**	Queen	..	NW	15	6	1	411	306	105	6	..	158,704
7	**Missouri & Illinois Coal Co.**	4	..	NW	30	6	4	497	72	425	6	..	126,726
8	St. Louis-Coulterville Coal Co.	Vulcan	SW	NW	18	4	4	520	275	245	7	..	61,404
9	**Bald Eagle Mining Co.**	..	..	NW	25	4	4	565	244	321	7	..	48,410
10	Wilson Coal Co.	..	..	SE	5	6	4	496	105	391	5	6	23,859
11	King City Coal & Mining Co.	..	..	SE	6	6	4	498	114	384	6	..	16,816
12	Little Muddy Fuel Co.	..	..	SE	29	4	1	505	211	294	5	8	13,794
13	Bailey Bros. Coal Co.	Diamond	..	NE	30	5	1	461	75	386	5	2	13 752
14	Brilliant Coal & Coke Co.	Horn	SW	SE	19	6	1	440	75	365	5	6	13,047
15	Greenwood-Davis Coal Co.	2	SW	SW	32	5	1	453	75	378	5	4	9,409
16	Bailey Bros. Coal Co.	Sun	..	SW	20	5	1	469	80	389	5	..	7,469
17	Strait Coal Co.	..	..	SW	13	5	3	401	86	315	6	2	3,255
	Dynamic Coal Mining Co.	3	..	..	..	..	..	..	..	..	6	..	1,292

Only about one-fourth of Randolph County is underlain by coal No. 6, but 23 mines added 712,058 tons to the State's production in 1913. All of the mining is done by shaft from coal No. 6. The writer is greatly indebted to Mr. Thomas Jeremiah of Willisville for details regarding the outcrop of the coal in the vicinity of Percy and Willisville.

TABLE 12.—*List of shipping mines, Randolph County, 1913*

Map No.	Company	Mine	Location					Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness		Production 1913
			¼	¼	Sec.	T. S.	R. W.						
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Willis Coal and Mining Co.	Goalby No. 6		NE	14	6	5	493	82	411	6	..	269,110
2	Jones Bros. Coal Mining Co.	Eureka No. 2	NW	NW	6	4	5	518	194	324	6	10	103,509
3	Wilson Bros. Coal Co.	7	NW	NW	8	5	5	500?	140	360	6	..	78,306
4	Illinois Fuel Co.	4	NE	NW	16	5	5	512	66	446	6	..	75,600
5	Moffat Coal Co.	1	SE	NE	8	5	5	523	123	400	6	..	74,318
6	Bessemer Coal & Mining Co.	Crystal	SW	NE	6	4	5	512	205	307	6	..	27,813
7	Bessemer Coal & Mining Co.	Tilden	SW	NE	6	4	5	512	180	332	6	6	26,805
8	Underwood Coal & Mining Co.		SE	NW	10	4	5	524	186	338	6	..	23,164
9	Randolph County Coal Co.	O. M.	NE	NW	13	4	5	545	300	245	6	6	13,932
10	Boyd Coal & Coke Co.	1	SW	SW	1	5	6	526	94	432	6	..	7,426

Washington County produced 246,932 tons of coal in 1913, of which 200,445 tons was hoisted at mine No. 5, Centralia Coal Company, sec. 25, T. 1 N., R. 1 W. The remaining 44,137 tons were produced at Nashville and at Dubois. All are shaft mines ranging in depth from 300 to 526 feet, and all are operating in coal No. 6.

TABLE 13.—*List of shipping mines, Washington County, 1913*

Map No.	Company	Location: Mine	¼	¼	Sec.	T.	R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness		Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Centralia Coal Co.	5	SE	NE	25	1N	1	497	520	-23	6	6	200,445
	Nicholson Coal Co.	Nashville		NE									36,844
3	Kuhn Coal Co.	Dubois			33	3S	1	490	295	195	5	6	7,293

COAL-BEARING ROCKS

The coal-bearing beds underlie all of Perry and Washington counties and the eastern third of Randolph County. They are known not only by studies of mine shafts but also from about 100 drill holes distributed by counties as follows: Perry 67, Washington 16, and Randolph 17. Most of the holes in Perry County were put down as coal tests, only 7 being oil holes; those of Washington are divided about equally between shallow and deep, and most of those in Randolph were drilled into the lower rocks for oil.

The outcrop of the "Coal Measures" is largely obscured by the glacial drift, but it has been traced from the western part of T. 7 S., R. 5 W. in a general northwest direction through Randolph County, intersecting the northern boundary in the eastern part of T. 4 S., R. 7. W. From the outcrop the beds dip northeast and since the surface remains comparatively level, a thickening of the coal-bearing strata takes place in this direction. In Ashley township more than 1000 feet of these beds are present, and farther northeast the thickness is still greater. At all places in the area the "Coal Measures" rest unconformably upon the Chester, which consists of interbedded limestones, sandstones, and red shales.

In Randolph County the coal is shallow except in the northeast corner near Coulterville where it is slightly more than 300 feet below the surface. The glacial drift of gravel, clays, and sands averages about 80 feet, consequently only a small amount of the Pennsylvanian rocks remains above the Belleville bed. A thin bed of coal representing coal No. 7 is in most places found 30 or 40 feet above coal No. 6, and the limestone cap rock over the latter coal is usually recorded in the logs. The following section is given by Worthen[a] as typical of

[a]Worthen, A. H., Geology of Randolph County: Ill State Geol Survey, vol. V, p. 281, 1866.

the beds that are exposed in the county near the western boundary of the "Coal Measures".

Worthen's section of coal-bearing rocks near western boundary in Randolph County

	Feet
Micaceous sandstone and shale	30 - 40
Limestone	.. 3
Shale	.. 12
Limestone-bituminous shale, in place replacing each other	4 - 6
Coal No. 6 (Belleville)	6 - 8
Shale or shaly sandstone	30 - 40
Limestone	3 - 4
Shale, bituminous	3 - 5
Coal No. 5	2 - 4
Fire clay	2 - 4
Shale and sandstone (conglomerate)	50 - 150

In the following log of a well located in NW. ¼ SW. ¼ sec. 6, T. 5 S., R. 5 W., the base of the "Coal Measures" is found at 493 feet. A bed of coal 4 feet thick lies 5 feet below coal No. 6. A similar coal is reported in 6 other logs from Randolph County; but all the holes were made by the churn drill, and the thickness is not reliable. The interval between coal No. 6 and this reported bed varies from 5 feet to 20 feet.

Record of Sparta City well, No. 3
Location—NW.¼ SW.¼ sec. 6, T. 5 S., R. 5 W., Randolph County

Description of Strata	Thickness *Feet*	Depth *Feet*
Drift	99	99
Limestone	10	109
Coal (No. 7)	2	111
Limestone	11	122
"Soapstone"	2	124
Sandstone	3	127
Shale	5	132
Limestone	17	149
Coal (No. 6)	6	155
Fire clay	2	157
Limestone	3	160
Coal	4	164
Limestone	40	204
Shale	13	217
Limestone	26	243
Coal	2	245
Sandstone	117	362
Shale	3	365
Limestone	7	372

Description of Strata	Thickness Feet	Depth Feet
Shale	19	391
Limestone	11	402
"Soapstone"	13	415
Sandstone	16	476
Shale	17	493
Limestone	16	509
Shale	14	523
Limestone	22	545
Shale	31	576
Sandstone	2	578
"Soapstone"	7	585
Limestone	13	598
Shale	5	603
Sandstone	15	618
Shale	15	633
Limestone	24	657
Shale	5	662
Limestone	22	684
Shale	8	692
Sandstone	7	699
Red rock	13	712
Limestone	15	727
Shale	3	730
Limestone	53	783
Shale	41	824
Limestone	11	835
Shale	16	851
Dark sand	4	855
Shale	11	866
Sandstone	5	871
Shale	9	880
Sandstone, hard	4	884
Shale	2	886
Sandstone	5½	891½

The following log is the record of an oil test near the Union Depot, Coulterville, sec. 13, T. 4 S., R. 5 W. The thickness of the lower coal is no doubt too large, but it is probably to be correlated with coal No. 5. The 215-foot sandstone at 640 probably represents the Pottsville, which probably occupies an ancient valley in the Chester rocks.

Record of Coulterville city well, No. 1

Location—Sec. 13, T. 4 S., R. 5 W.

Description of Strata	Thickness Feet	Depth Feet
Drift	30	30
Shale	50	80
"Soapstone"	20	100

Description of Strata	Thickness Feet	Depth Feet
Shale, black	40	140
"Soapstone"	15	155
Shale	45	200
"Soapstone"	20	220
Shale	75	295
Limestone	15	310
Coal (No. 6)	7	317
"Soapstone"	30	347
Shale	25	372
Shale, black	23	385
Coal (No. 5, probably incorrectly reported)	8	393
Shale	20	413
Limestone	7	420
Shale, black	10	430
Limestone	5	435
Shale, white	20	455
Limestone	10	465
Shale, white	25	490
Limestone	20	510
"Soapstone"	15	525
Shale, brown	20	545
Sand, white (fresh water)	55	600
Shale	40	640
Sand	215	855
Shale	10	865
Limestone	10	875
Shale	15	890
Limestone	20	910
Shale	40	950
Red rock	10	960
Limestone	40	1000
Red rock	30	1030
Limestone	20	1050
Shale	25	1075
Shale, red	25	1100
Sand, white (salt water) (Benoist?)	17	1117

In Perry County about 1200 feet of the "Coal Measures" strata are present. West of the Duquoin anticline all the rocks dip northward at a uniform rate, but from the axis of the fold which extends through Duquoin and parallels the Illinois Central railroad the beds dip steeply to the east, and coal No. 6 which outcrops at Duquoin is almost 500 feet below the surface three miles to the east.

The most noticeable difference in the stratigraphy east and west of the anticline is the large interval between coal No. 6 and its roof limestone on the eastern side of the fold. A progressive thickening of the shale is apparent in an easterly direction from the crest of the fold, as illustrated by figure 31. It seems probable that shortly after

the deposition of the roof material began, subsidence proceeded rapidly east of the line which marks the axis of the fold, allowing a large amount of muds and silts to be carried into the basin; whereas on the west side of the axis only a few feet of sediment accumulated. The

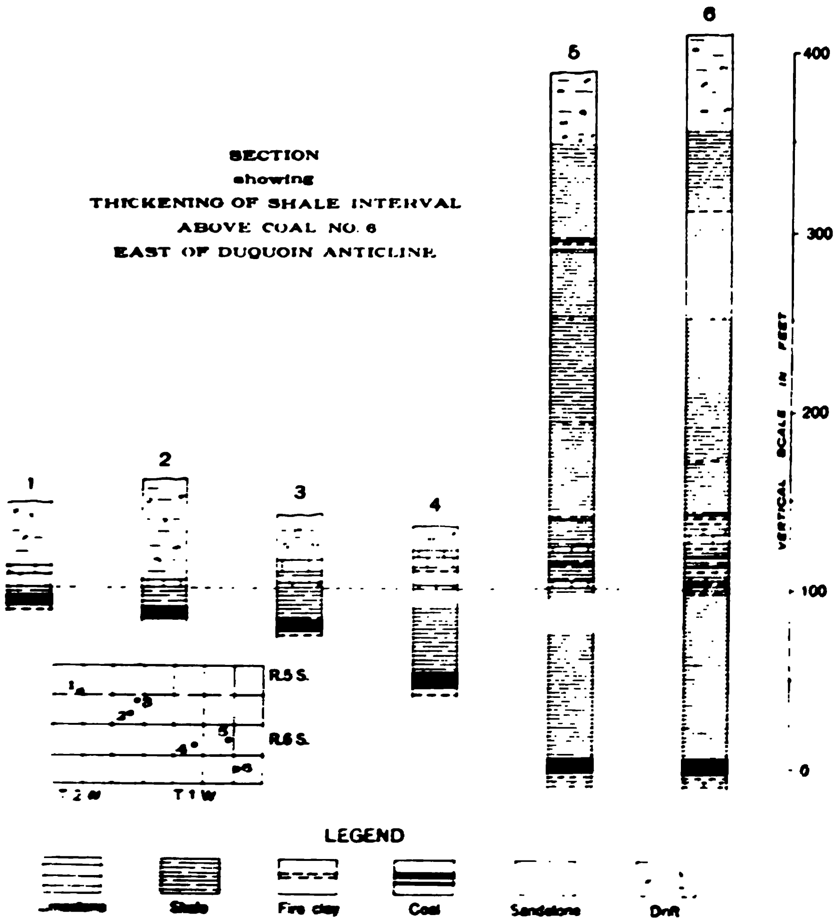

Fig. 31.—Section showing the thickening of the shale interval above coal No. 6 east of the axis of the Duquoin anticline

sea then became clear, and limestone was deposited over the entire area. Further sinking began, the eastern side again being in the lead, and the result was a sharp folding of the coal with a somewhat smaller effect on the limestone and the other beds above the coal. In the eastern side of the county about 100 feet of shales overlie the coal.

Several of the holes in the eastern part of the county show a thin coal above the limestone in the proper position for coal No. 7 al-

though of course it is almost 100 feet higher than is usual west of the fold, because of the increased amount of shale mentioned above. One hole in sec. 2, T. 6 S., R. 1 W. shows a thick limestone about 400 feet above coal No. 6. At this place it lies next below the glacial drift. and its boundary no doubt passes southeast into the northern part of Jefferson County.

The following log of Midvalley Oil Company's well in NW. ¼ SW. ¼ sec. 17, T. 6 S., R. 3 W. was made by J. A. Udden from samples which were shipped to the office by the company. The printed log includes only the "Coal Measures," although the well was continued to 1198 feet. This well is located near the outcrop of coal No. 6, and it is likely that the coal fragments at 40 feet are from that bed. The detailed description of the coals will be given later in this chapter.

Well record of Midvalley Oil Company
Farm and well—Gallagher No. 1
Location—NW.¼ SW.¼ sec. 17, T. 6 S., R. 3 W.
(Description by J. A. Udden)

Description of Strata	Thickness *Feet*	Depth *Feet*
Loess, yellow	6	6
Surface clay, yellow and some sand grains	9	15
Sample lost	9	24
Drift, sand, and pebbles and a little dark shale	8	32
Loess, yellow, and other drift	8	40
Sand, coal fragments and drift pebbles (probably fragments of coal No. 6)	8	48
Sandstone, gray, micaceous and drift pebbles	10	58
Shale, gray, siderite, black shale, gray limestone, drift pebbles and chert	9	67
Sand, siderite, and drift pebbles	7	74
Shale, gray, weathered, containing some calcareous material	10	84
Limestone, black, and yellow glass (?)	13	87
Shale, black, slaty, slightly bituminous, some coal and yellow glass	5	92
Shale, black, some limestone, some sandstone and some fire clay	6	98
Sandstone, gray, and yellow, concretionary limestone, black shale and mineral charcoal	7	105
Shale, dark gray, micaceous	9	114
Shale, gray, sandy, micaceous, showing dark and light laminae, and gray sandstone with imbedded yellow spherules of siderite	6	120
Sandstone, gray, white, and yellow, and dark gray, sandy shale and some white and yellow sandstone. Some of the sandstone contains shreds of carbonaceous material and some contains spherules of siderite	7	127

Description of Strata	Thickness *Feet*	Depth *Feet*
Shale, black, very bituminous, waxy to the knife, and a dark gray, coarse, organic, brecciated limestone	8	135
Shale, black, "clod" containing a small tuberculated gasteropod and other fragments of other fossils, coal, and fire clay	8	143
Coal and some fire clay	4	153
Sandstone, gray, micaeous, and some fire clay	7	160
Sandstone, white, micaceous	6	166
Sandstone, gray, with imbedded spherules of siderite	6	172
Clay shale, gray, and gray sandstone, siderite, pyrite, and some limestone	6	178
Shale, gray, sandy, and black shale, limestone, concretionary siderite and pyrite	6	184
Shale, gray, and fire clay, coal, black shale and pyrite	6	190
Shale, black, and gray fire clay, coal, pyrite and some limestone	6	196
Shale, black, and coal, organic, calcareous fragments, woody tissue, pyrite and fire clay	6	202
Shale, sandy, gray and some greenish-gray shale	4	206
Shale, gray, some coal and limestone	6	212
Shale, gray, and black; shale, coal, siderite and limestone	6	218
Sandstone, gray, and gray shale, black shale, coal and pyrite	6	224
Shale, dark and black, and gray sandstone, concretionary siderite, carbonaceous, woody tissue and pyrite	6	230
Shale, black, and gray sandstone, siderite, fragments of red, brown, and yellow stone	6	236
Limestone, yellowish-gray and gray shale, gray, sandy shale, bright red rock fragments and sandstone	6	242
Sandstone, dark gray, soft and of fine texture	6	248
Shale, gray sandy, and siderite, pyrite, and some white calcareous fragments	6	254
Shale, gray, with some siderite and pyrite	6	260
Shale, gray, and gray sandstone with carbonaceous fragments, some fragments of red rock, some limestone and pyrite	6	266
Shale, dark, and light-gray shale with fragments of siderite	6	272
Coal, siderite, fire clay and pyrite	6	278
Shale, black, containing laminae of coal, white and gray limestone with crinoid stem and a small tuberculated gasteropod. Pyritized woody tissue, and bright red rock noted and some siderite	6	284
Pyrite, black shale, pyritized woody tissue, siderite, some calcite and some limestone	6	290
Limestone, gray, and concretionary siderite and pyrite	5	295
Shale, gray, micaceous, and some gray sandstone with carbonaceous shreds and some siderite	6	301
Shale, dark, micaceous, with some fragments of calcareous material	5	306
Sandstone, gray, and gray shale	6	312

Description of Strata	Thickness Feet	Depth Feet
Sandstone, white, micaceous, laminated with some shale	6	318
Sand, white	16	334
Sandstone, gray, and red; siderite, black shale, pyrite, spherules of siderite and limestone	6	340
Sandstone, white, and some shale	6	346
Sand, coarse, white	6	352
Sandstone, white, micaceous, coarse, with a few fragments of limestone, pyrite and siderite	6	358
Sand, white	12	370
Sandstone, white, fairly coarse	6	376
Sand, white, micaceous	8	384
Sandstone, light gray	6	390
Sand, white, micaceous	5	401
Sandstone, white, some shale and calcareous material	3	404
Shale, light, dark gray, and a little brown, and fine sandstone	3	407
Sandstone, fine, white, micaceous	3	410
Sand, coarse, white	5	415
Sandstone, laminated, white, micaceous. A pebble of quartz about ⅛ in. noted	5	420
Sandstone, fine, white, micaceous	5	425
Sand, gray, micaceous	5	430
Sand, gray	5	435
Sand, coarse, of many well-rounded grains	5	440
Sandstone, white and gray, of coarse rounded grains, with infiltrated carbonate of lime and some small pieces of shale	5	445
Sand, coarse, gray, micaceous and a little dark shale	5	450
Sandstone, fairly coarse, gray	5	455
Sand, white	6	461
Sandstone, coarse, white, and a little pyrite	5	466
Sandstone, white, micaceous	6	472
Sandstone, white	12	484
Sand, white, micaceous	6	490
Sand, white	18	508
Sand, pure white	6	514
Sand, white	6	520
Sand, coarse, white	5	525
Sandstone, gray, calcareous of fine texture	5	528
Shale, mostly gray, dark and black; and some sandstone and quartz grains	5	535
Sandstone, limestone, pyrite and shale	5	540
Shale, dark, and white sandstone and a little limestone	6	546
Sandstone, gray and red, and gray shale and pyrite	6	552
Sandstone, white, micaceous, and some gray shale	6	558
Sandstone, white, fairly coarse	6	564
Sand, gray, micaceous, and a little dark shale	5	569
Sandstone, white, and a little red shale. Sand grains with secondary crystals	5	574
Sandstone, pink, purple, brown, yellow and white	6	580

Description of Strata	Thickness *Feet*	Depth *Feet*
Sandstone, white, gray, dark, pink, and brown	5	585
Sand, white quartz	5	590
Sand, white, with secondary crystallization	6	596
Sandstone, white, and a little gray shale	6	602
Sand, white, with some grains showing secondary growth	6	608
Sand, clean white	6	614
Sand, pure white, secondary crystallization	6	620
Sandstone, white, and a few grains of coal	5	625
Sandstone, white and fine grained, and pyrite, a little coal and a little shale	5	630
Limestone, black and white shale, fine sand, and quartz crystals	5	635
Sand, gray, micaceous, and a little gray shale	5	640
Quartz sand, fine grained, some black shale and fragments of limestone	5	645
Sand, gray	5	650
Sand, gray, micaceous, and fairly coarse, and a little shale, and some limestone	5	655
Sandstone, white, with dark laminae, fragments of coal, some shale fragments of siderite concretions, some pyrite and some red grains	5	660
Sandstone, white	5	665
Sand, gray, micaceous, some limestone and some gray shale	5	670
Sandstone, gray, and pink; and dark gray shale	5	675
Sandstone, gray, calcaceous, showing minute shreds of vegetation and pyrite	5	680
Limestone, dark, and shale, some calcite, pyrite, and a little white limestone. Brachiopod spine noted	5	685
Shale, gray, with some fragments of limestone and pyrite	5	690
Shale, bluish, black, and organic fragmental limestone	5	695
Sandstone, gray, calcareous, dark gray shale and some fragments of black bituminous material, some gray limestone and pyrite	5	700
Sandstone, gray, red, and white; and gray and black shale, and some limestone. Aspect: Pottsville	5	705
Sandstone, gray, dark shale, some red, green, brown, fragments of limestone, and a little pyrite	5	710
Sandstone, gray, and dark shale	5	715
Sandstone, gray, micaceous, and some black shale	5	720
Sandstone, gray, and black shale, some coal, some petrified wood and some pyrite	3	723
Sandstone, gray, laminated of fine texture	4	727
Sa dstone, laminated, dark gray, and fragments of pyrite	5	732
Sandstone, gray, showing carbonaceous shreds and layers	6	738
Shale, greenish black, with few fragments of red shale	6	744

In Washington County the coal-bearing beds range in thickness from 600 feet in the southwestern to 1200 or 1300 feet in the northeastern part. Coal No. 6 is 160 feet deep in the southwest corner.

and the dip carries it 520 feet below the surface at Centralia Coal Company's mine No. 5 near the northeast corner of the county. The strata above the coal consist largely of shales which are variable in character and cannot be correlated from one hole to another.

The following records of coal shafts at Ashley and mine No. 5, Centralia Coal Company, show typical sections of the beds above coal No. 6.

Well record of Ashley mine shaft (abandoned)
Location—NW.¼ sec. 26, T. 2 S., R. 1 W., Washington County.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
No record	123	..	123	..
Limestone	9	..	132	..
"Slate"	4	..	136	..
"Soapstone"	12	..	148	..
Coal	..	10	148	10
Conglomerate	4	6	153	4
Fire clay	1	6	154	10
Sandstone	46	6	201	4
Shale, blue	5	..	205	4
Shale, black	4	..	209	4
Lime	1	..	210	4
Shale, blue	2	6	212	10
Fire clay	4	6	217	4
Conglomerate	3	6	220	10
Shale, sandy	21	..	241	10
Shale, blue	3	6	245	4
"Soapstone"	3	..	248	4
Shale, sandy	41	..	289	4
"Slate", blue	18	..	307	4
"Slate", blue	3	6	310	10
"Slate", black	2	6	313	4
Lime	1	..	314	4
Coal	1	..	315	4
Fire clay	3	..	318	4
Shale, blue	5	6	323	10
Sand	22	..	345	10
"Soapstone"	83	..	428	10
Lime, gray	..	6	429	4
Fire clay	1	6	430	10
Sand	3	6	434	4
Lime	1	6	435	10
Shale, black	1	6	437	4
Shale, blue	5	..	442	4
Shale, black	6	..	448	4
Lime, gray	2	..	450	4
Lime, white	1	6	451	10
Shale, blue	6	..	457	10
Lime	14	..	471	10

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
"Slate", black	2	..	473	10
Coal and dirt	4	6	478	4
"Soapstone"	6	..	484	4
Coal	..	8	485	..
Shale, "soapstone"	..	4	485	4
"Soapstone", shale	3	6	489	10
Coal seam worked (No. 6)	5	..	495	10

Shaft record of mine No. 5 of Centralia Coal Co.
Location—SE.¼ NE.¼ sec. 25, T. 1 N., R. 1 W.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Surface	16	..	16	..
Shale, soft, black	4	..	20	..
Shale, black clay	38	..	58	..
Conglomerate lime	1	..	59	..
"Slate", black	1	..	60	..
Coal	..	3	60	3
Fire clay	11	6	71	9
Shale, black, sandy, and light sandy peat	14	..	85	9
Conglomerate sand rock	1	6	87	3
Shale, black, sandy	2	9	90	..
Lime, conglomerate	..	6	90	6
Shale, black, sandy	3	..	93	6
Lime, conglomerate	2	3	95	9
Sand rock	1	9	97	6
Clay shale, black	2	6	100	..
Coal	..	6	100	6
Fire clay	..	6	101	..
Clay shale	1	3	102	3
Shale, black, sandy	3	..	105	3
Sand rock	5	..	108	3
Clay shale	..	3	108	6
Coal	..	6	109	.
Fire clay, dark	3	9	112	9
Shale, dark, sandy and light sandy peat	16	..	128	9
Clay shale, black	14	..	142	9
Lime	2	..	144	9
Fire clay	4	..	148	9
Clay shale	25	..	173	9
Lime, shaly	1	6	175	3
Limestone, gray (Carlinville)	9	9	185	..
"Slate", black	3	6	188	6
Clay shale	3	3	191	9
Coal	..	3	192	..
Fire clay lime pebbles	4	9	196	9
Fire clay and lime mixed	2	..	198	9
Shale, black, sandy	28	..	226	9

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Clay shale, blue	19	..	245	9
Lime, conglomerate	2	..	247	9
"Slate", black	2	6	250	3
Lime, conglomerate	1	6	251	9
Fire clay, dark	5	..	256	9
Lime, blue, sandy	12	..	268	9
Clay shale, blue	44	..	312	9
Sand rock	5	..	317	9
Sand rock, and dark shaly peat	5	..	322	9
Shale, blue, sandy, and sandy peat	3	..	325	9
Clay shale, dark, and limey peat	11	..	336	9
Lime, conglomerate	1	..	337	9
Clay shale, dark	5	..	342	9
Coal (No. 8)	1	..	343	9
Fire clay, lime pebbles	3	..	346	9
Lime, sandy	3	6	350	3
Fine rock	1	..	351	3
Shale, sandy	4	..	355	3
Sand rock, oil-bearing	4	..	359	3
Shale, blue, sandy and light sandy peat	5	6	364	9
Shale, blue, sandy	68	..	432	9
Clay shale, blue	23	..	455	9
Fire clay	3	..	458	9
Sandy shale, blue	8	..	464	9
Shale, dark, sandy and light sandy peat	3	6	468	3
"Slate", black	..	6	468	9
Fire clay	2	..	470	9
Fire clay, dark	3	..	473	9
Fire clay, hard, dark	2	..	475	9
Lime rock, gray	5	..	480	9
Fire clay	4	..	484	9
Shale, dark	2	9	487	6
Coal (No. 7)	1	6	489	..
Fire clay	3	..	492	..
Coal	..	6	492	6
Fire clay	1	6	494	..
Shale, dark	..	3	494	3
Coal	..	9	495	..
Fire clay, sandy	2	..	497	..
Fire clay, green and lime	2	3	500	9
Lime, gray	3	..	503	9
Lime, gray and dark shale	3	..	506	9
Lime, gray	1	..	507	9
Shale, dark	2	..	509	9
Lime, dark	7	..	516	9
Lime rock, black	6	6	523	3
"Slate", black	2	..	525	3
Coal (No. 6)	6	6	531	9
Fire clay	..	6	532	3

Below is given the log of a well drilled by the Gibson estate on the Finke farm. Coal No. 6, its cap rock, and a 5-foot bed 100 feet lower are the only coals noted.

Drill record of Veitch, Gibson Co.
Location—Sec. 12, T. 2 S., R. 3 W.

Description of Strata	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Pennsylvanian strata—				
Soil	12	..	12	..
Gravel	12	..	24	..
Shale and some limestone	326	..	350	..
Limestone, hard	26	..	376	..
Coal (No. 6)	6	..	382	..
Shale and some limestone	98	..	480	..
Limestone	2	6	482	6
Coal (No. 5)	6	6	489	..
Shale and some limestone	66	..	555	..
Sandstone (little salt water)	8	..	563	..
Shale and some limestone	147	..	710	..
Sandstone (salt water)	70	..	780	..
Shale and limestone	8	..	788	..
Sandstone	22	..	810	..
Shale	30	..	840	..
Sandstone (much salt water)	15	..	855	..
Shale	35	..	890	..
Sandstone (much salt water)	60	..	950	..
Shale	40	..	990	..
Mississippian series—				
Chester group—				
Sandstone (salt water)	10	..	1000	..
Shale and red rock	20	..	1020	..
Sandstone (Carlyle) (good show of oil)	14	.	1034	..
Sandstone (salt water)	31	..	1065	..
Sandstone and some red rock (salt water)	80		1145	..
Sandstone (salt water)	60	..	1205	..
Shale	25	..	1230	..
Limestone	5	..	1235	..
Sandstone (show of oil)	10	.	1245	.
Sandstone	55		1300	.
Shale and red rock	125	.	1425	.
Sandstone	35		1460	.
Shale and red rock	40		1500	.
Limestone	5	.	1505	
Sandstone	10	.	1515	
St. Louis formation—				
Limestone, hard	1	..	1516	..

In the northeast half of the county it is generally possible to recognize the Carlinville limestone in drillings or on the outcrop. In the Huegeli shaft at Nashville it lies 80 feet below the surface, and it is exposed north of Nashville along the west side of the creek in the NW. ¼ sec. 13, T. 2 S., R. 3 W. It has also been quarried in the SW. ¼ sec. 34, T. 2 S., R. 2 W. Ordinarily the fresh limestone is bluish-gray and very hard and breaks into irregular pieces. It turns brown on weathering. In Washington County it lies about 300 feet above coal No. 6 and its dip carries it from the outcrop to a depth of 150 to 200 feet or more in the northeast corner of the county. Although it averages but 7 feet in thickness, it is persistent and can be traced from point to point with considerable success.

Below coal No. 6 is a series of shales and sandstones ranging in thickness from 400 to 800 feet, the irregularity being due to the unconformity at the base of the "Coal Measures." Most of the records make no mention of coals below coal No. 6, but it is believed that the apparent absence of the lower coals is due to the unsatisfactory work of the churn drill. Three logs in different parts of the county record a coal lying at intervals of 70, 110, and 150 feet respectively, and ranging in thickness from 3 to 5 feet. They probably do not represent the same bed, but their presence adds strength to the belief that careful drilling will disclose at least small areas of workable coal below No. 6.

Geologic Structure

Most of the area concerned in this report is underlain by beds that have a general northeast dip averaging 12 feet per mile, as shown by the position of coal No. 6. Minor undulations exist, the axes of which extend in the direction of the dip. For detailed description of the Venedy dome, the White Oak anticline, and the Nashville anticline the reader is referred to "Geological Structure" in Part I of this bulletin.

The major structural feature of the region is the Duquoin anticline, the axis of which enters the county in the eastern part of T. 6 S., R. 2 W., extends about N. 10 E. through Duquoin, thence practically parallel to the Illinois Central Railroad as far north as Sandoval, north of which it loses its identity. The fold is best known in T. 6 S., R. 1 W., Perry County, where a large amount of mining and drilling have been done. At Duquoin and for some distance west the beds lie almost flat, but east of the city the dip reaches as much as 300 feet per mile. Figure 32 is a structure section across the anticline. The position of the structural contours is not definitely known but the eastern dip is steep along the west side of Jefferson County;

whereas west of the axis the beds show a uniform, northward dip. In other words, the axis of the fold dips gently north-eastward.

It seems certain that in some way a barrier existed along the line of the Duquoin fold for at least some distance north during the deposition of the coal, because the coal east of the axis, not only in

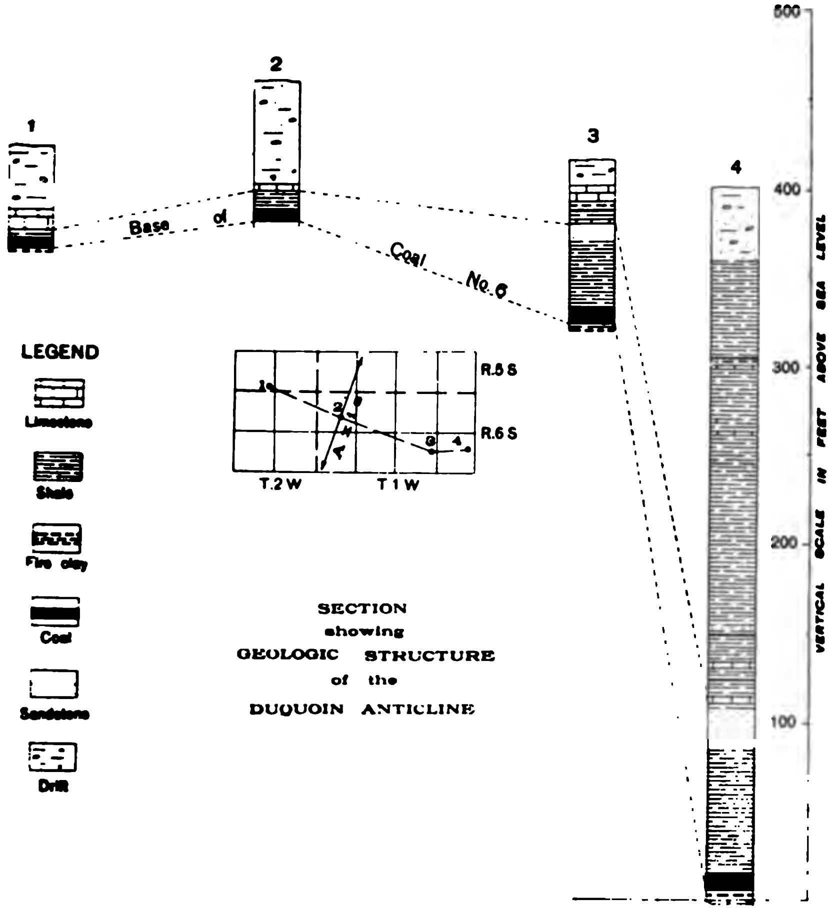

FIG. 32.—Section showing structure of the Duquoin anticline.

southeast Perry County, but also in Franklin and Williamson counties, differs physically and chemically from the coal deposited contemporaneously west of the axis. The difference in the coals is most noticeable as far north as the northern boundary of Franklin County. No such change is apparent east of the fold in Marion County, and it is not now known where the Franklin-Williamson type of coal No. 6 stops and the Belleville type begins on the east side of the Duquoin fold.

The absence of the coal at Ashley and Irvington, on the axis of the fold, may signify former submergence in that part of the region now occupied by the fold. Scattered records in western Jefferson County show irregularities in the coal, including thick partings of shale, especially in the upper part of the bed, and are significant because they are apparently related to the irregular conditions noted above. These, in turn, may be connected with the barren area disclosed by the Oppenlander well, sec. 16, T. 2 S., R. 1 W., and by a well in sec. 4, T. 2 S., R. 2 W. Data are now too meagre to unravel the true conditions, but future investigation may prove that the area of thin or irregular coal, as mapped in western Clinton County, continues southeastward through northeastern Washington County and includes the territory near Ashley and Irvington. The latter territory may have been below sea level so that instead of receiving coal deposition, it formed an area of sluggish drainage, south of which the embryonic fold acted as a barrier between the eastern and western parts of the coal basin. At least the effect of such a barrier is not apparent north of Perry County. Some faulting occurred coincident with the formation of the Duquoin anticline. Those faults encountered in mining will be described under the subject "Roof and Floor."

Coal No. 6

DISTRIBUTION AND THICKNESS

An area of 694 square miles in Perry County is underlain by coal No. 6, this being the entire county except an irregularly shaped tract in the south central part aggregating 49 square miles. The outcrop enters the county about 1 mile south of Willisville, extends east across Galum Creek, thence northeast swinging across Beaucoup Creek, southwest along the tributary of Beaucoup to sec. 20, T. 6 S., R. 2 W., thence east to the central part of section 24, and south to the county line. The position of the outcrop on the map is based on all available information, but later some revision will doubtless be necessary, especially in the vicinity of Beaucoup Creek. North and east of this line coal No. 6 is persistent throughout the county.

West of the Duquoin anticline the bed shows the uniform thickness of 6 feet, but east of the axis in T. 6 S., R. 1 W. the average thickness is increased to 8 feet. Coal No. 6 is thinnest on the crest of the broad fold where it is near the surface. That it is consistently thinner along the crest probably signifies that less vegetal material was deposited, but in places near Duquoin erosion removed part or all of the coal before the glacial material was deposited. Such erosion is particularly noticeable in parts of secs. 7 and 16, T. 6 S., R. 1 W.

A few of the mining companies operating near Duquoin have found by drilling that the coal is absent along certain northwest-southeast lines which suggest former stream channels. It has also been noted that near the barren areas the coal is split into a number of benches by shale partings, the result, perhaps, of the interbedding common to stream deposits, a condition no doubt related to the succession of low and high-water periods. The erosion channels at Duquoin are not so large as those in Montgomery County and appear to affect only the top of the fold near the southern outcrop. The mines along the crest of the fold show coal ranging in thickness from 5 feet 2 inches to 5 feet 10 inches.

In Randolph County, the outcrop forms an irregular northwest-southeast line from a point one mile south of Willisville to the northwest corner of sec. 4, T. 4 S., R. 6 W. The streams in this part of the county flow southwest and, since the dip of the rocks is towards the northeast, the coal outcrop may be followed up the sides of the valleys to the point where the bed dips beneath the channel. Originally the coal was mined along the outcrop near Percy and in the vicinity of Sparta. Later it was mined by shallow shafts in the same region and finally deeper shafts were sunk in the northeast corner of the county.

Detailed measurements at the face of the coal in 9 mines show that the bed averages 5 feet 11 inches in thickness; whereas 19 drill holes distributed throughout the coal-bearing area indicate an average thickness of 6 feet 1 inch.

The coal of Washington county is not well known, since in its shallowest parts it lies 200 feet below the surface and the streams do not erode sufficiently deep to expose it. Information regarding the coal is confined to the few shafts and about 15 drill holes in different parts of the county. The available records indicate that coal No. 6 is developed over a large part of the county. It is known to be somewhat thinner than normal along the axis of the Duquoin fold in the eastern tier of townships, and its absence at Irvington and also in sec. 16, T. 2 S., R. 1 W. and in sec. 4, T. 2 S., R. 2 W. suggests some connection with the barren area towards the northwest in Clinton county. It is also possible that the absence of coal in the drill holes mentioned is due to the same processes that reduced the thickness of the coal in the eastern part of Clinton county. Before any definite relationship can be established however other holes must be drilled in the northeast quarter of Washington county. The drill records available for study are from wells so widely separated that generalizations regarding distribution and thickness of coal No. 6 are almost worthless. It

is regarded best, therefore, to present the known information in tabulated form.

TABLE 14.—*Thickness of coal No. 6 in Washington County*
From drill records and logs of mine shafts

Company		Location Sec.	T.	R.	Coal No. 6 Depth	Thickness Ft.	In.
Drill holes:					*Feet*	*Ft.*	*In.*
Irvington Coal Co.	Irvington	..	..	..	Absent	..	..
Centralia Coal Co.	SE.¼ NE.¼	25	1N	1W	525	6	6
Central Refining Co.		17	1S	4W	335	10	..
Ashley shaft	Ashley	..	2S	1W	497	5	..
Schaffer & Smathers	Ashley	..	2S	1W	Absent	..	..
Ohio Oil Co.		16	2S	1W	Absent	..	..
Egyptian Heat & Power Co.		4	2S	2W	Absent	..	..
Gibson Estate		12	2S	3W	376	6	..
Consolidated Coal Company		13	2S	3W	418	6	..
M. H. Cohen		21	2S	3W	325	1–2	
R. Zeppenfeld		29	2S	4W	216	8	..
C. L. Coulter	NW.¼ SW.¼	13	3S	4W	351	7	..
Shoup Oil Co.		14	3S	4W	303	3	..
David Thomas	Oakdale	..	..	..	345	7	..
Mine shafts:							
Finke & Harris Coal Co.	NE.¼ SE.¼	13	2S	3W	424	7	..
J. A. Kuhn	NE.¼	33	3S	1W	294	5	6
Gallatin Coal & Coke Co.	Nashville	..	..	..	419	6	4

PHYSICAL CHARACTER

The coal of Washington, Randolph, and the western parts of Perry counties, differs physically and chemically from that east of the Duquoin anticline where it is thicker, and contains less dirt and a smaller percentage of sulphur. The latter coal belongs with that of Franklin-Williamson or District VI of the Investigations. In treating the subject of coal resources in county units, however, some overlapping of districts is unavoidable.

Figures 33, 34, and 35 show the physical character of coal No. 6 in some of the mines of Perry, Randolph, and Washington counties. On both sides of the fold the bed shows the usual division into three benches, and the "blue band" maintains its position and general characteristics. As a whole, on the west the bed has a duller luster than on the east. In most places the top coal is not left in mining except below bad roof as at the Horn mine 1½ miles southwest of Duquoin, where 18 inches of coal forms the roof and is separated from the middle bench by a parting of charcoal and pyrite.

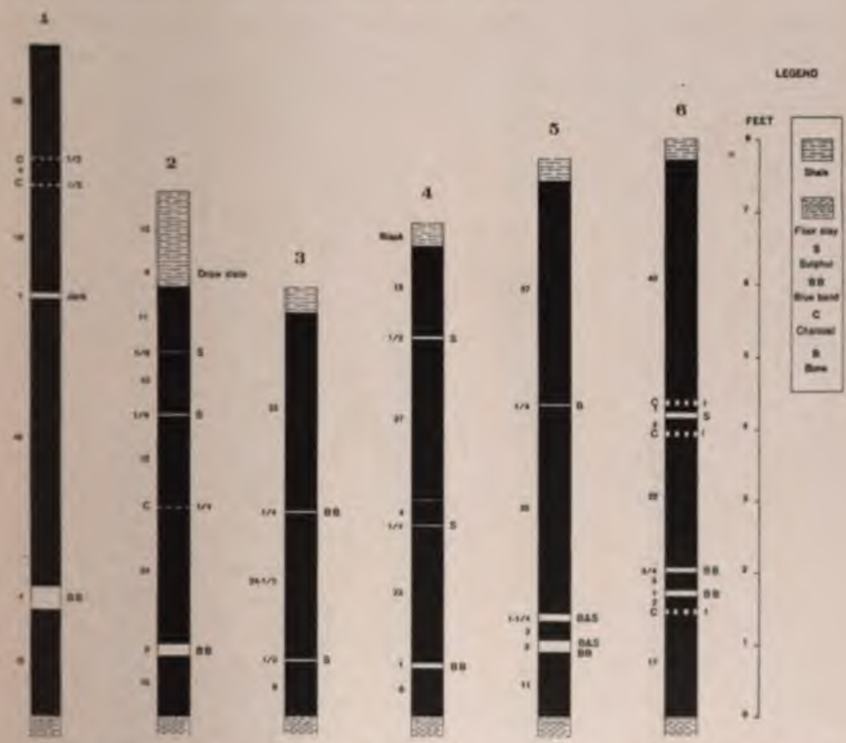

FIG. 33.—Graphic sections of coal No. 6 from measurements made in mines in Perry Co.

1. Paradise Coal and Coke Co., Paradise mine, Duquoin.
2. King City Coal and Mining Co., Barnard mine, Cutler.
3. Little Muddy Fuel Co., Little Muddy mine, Tamaroa, 2nd. north entry.
4. Willis Coal Mining Co., No. 1, Willisville. Room 10, 13th. S. off main east entry.
5. Brilliant Coal and Coke Co., Horn mine, Duquoin. Room 24, 7th. S. off 7th. W. on N.
6. Ritchey Coal Co., No. 1, Pinckneyville. Face 4th. off main N., 1000 feet from shaft.

East of the anticline the character of the coal is seen typically at the Paradise and Muddy Valley mines. In the former the bed varies in thickness from 8 to 11 feet, the average being 10 feet. The top coal measures 26 to 30 inches and the lower bench averages 18 inches. At the latter mine the coal varies in thickness from 6 to 11 feet on the east side of the mine and is but 7 feet on the west. The "blue band" on the west is but 1½ inches thick and from 7 to 10 inches on the east and consists of bone, coal, and dirt. At the Paradise mine also the "blue band" is peculiar in that it consists of an upper and lower layer of shale varying from 1 to 2 inches in thickness, and separated by about one inch of coal. Various names are applied to particular partings or to benches develped at individual mines. At the abandoned mine of the Greenwood-Davis Coal Co., Duquoin, a softer coal is

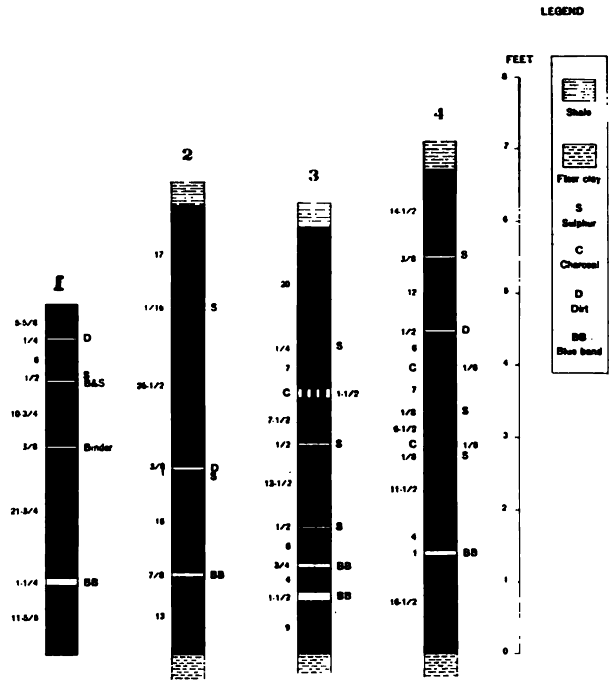

FIG. 34.—Graphic sections of coal No. 6 from measurements made in mines in Randolph County.

1. Boyd Coal & Coke Co., No. 1, Sparta. Main north, 600 feet from main west.

2. Bessemer Coal and Mining Co., Crystal mine, Tilden. Room 16, 6th west off main south.

3. Moffatt Coal Co., No. 1, Sparta. Face 4th west off main S., 2800 feet from shaft.

4. Willis Coal and Mining Co., No. 6, Percy. Room 16, 1st south, main east.

esent below the 26-inch top bench, and to this is given the name ine inch ply". Such terms as "drift band," "steel band" and others e applied to local features in certain mines. Besides the "blue band" hich is persistent and the parting below the top coal, no other partings n be consistently traced from one mine to another.

At Nashville in Washington County the coal appears to contain icker shale partings than elsewhere, and below the lower bench 12 to

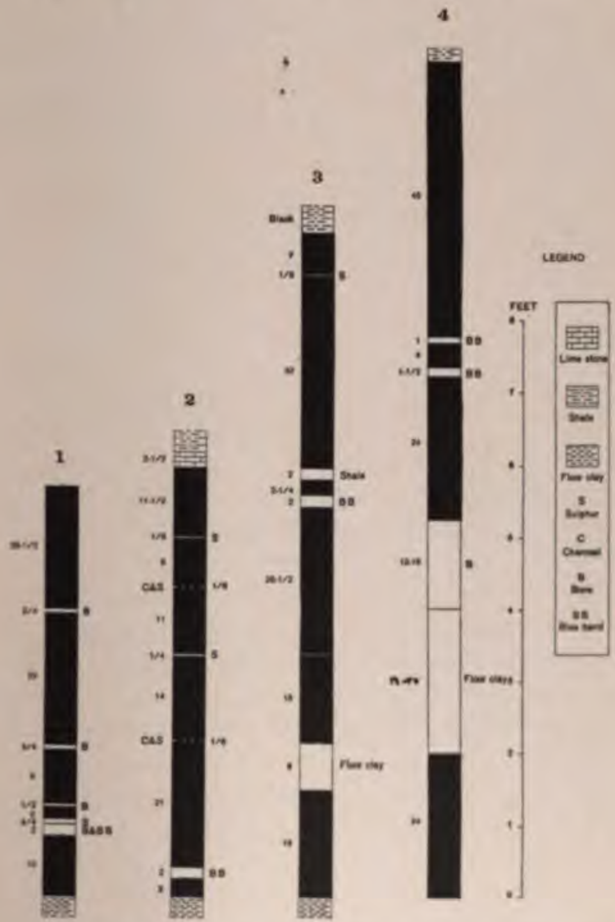

FIG. 35.—Graphic sections of coal No. 6 from measurements made in mines Washington Co.

1. Centralia Coal Co., No. 5, Centralia. Room 1 off 4th N.
2. Kuhn Coal Co., Dubois. 2nd. W. main entry.
3. Finke and Harris Coal Co., No. 1, Nashville. (Abandoned.) Main N. ntry, 4200 feet from shaft.
4. Gallatin Coal and Coke Co., Nashville. Room 3 on 2nd. W. off main . (Abandoned.)

18 inches of bone and a foot or two of clay overlie a small bed of coal ranging in thickness from 18 to 24 inches. The main part of the bed seems to be intact, the "blue band" being in its proper place, and the small coal below is probably a local development in a small basin.

The following section was measured at the face 4200 feet from the shaft on the main north entry, in mine No. 1, Finke and Harris Coal Company, Nashville, now abandoned.

Section of coal, Finke and Harris mine No. 1, Nashville

	Thickness	
	Ft.	*In.*
Shale, roof, black	2	..
Coal	..	7
Pyrite	..	1/8
Coal	2	8
Shale	..	2
Coal	..	2 1/4
"Blue band"	..	2
Coal	2	1 1/2
Bone coal	1	3
Clay	..	8
Coal	1	6
Clay	1	6
	12	8 7/8

The "blue band" in this mine appears as a double parting separated by a few inches of coal, but the upper band of shale is not uniform in thickness.

At Dubois the coal averages 5½ feet in thickness, and the only difference in the character of the bed is the position of the "blue band" only 2 or 3 inches above the floor. In the extreme northeast corner of the county, which is part of the Centralia field, the coal varies from 5 feet 4 inches to 8 feet in thickness, and the "blue band" lies from 3 to 12 inches above the bottom.

Throughout the district, a considerable amount of gypsum and some calcite are deposited in the cleavage planes of the coal.

ROOF AND FLOOR

West of the axis of the Duquoin anticline the normal roof of coal No. 6 is black shale overlain by a strong, gray limestone. In places a gray shale or "white top" partly or entirely replaces the black shale, and in others the limestone rests directly on the coal. East of the anticline the shale increases in thickness eastward, and what appears to be the same limestone that overlies the coal to the west is found 100 feet or more above it in the southeast corner of the county.

There seems to be no regular succession of black and gray shale, the order depending on local conditions at the time of deposition. At the Horn mine near Duquoin gray shale overlies the coal to an average height of 12 feet, and in places as much as 23 feet is known. The black shale forms the roof in only a small area. At Willisville black shale lies over the coal in most of the mine, the maximum thickness being 3 feet. A "white top" roof from 2½ to 4½ feet thick containing numerous slickensides, which cause it to fall when unsupported in circular and lenticular masses, prevails through 15 per cent of the mine. The same lenticular, gray shale is seen at the Ritchey mine in Pinckneyville where it exists as a lens between the coal and black shale throughout 50 per cent of the mine. A dark-colored shale ranging in thickness from a mere streak to about 18 inches and averaging from 2 to 4 inches, lies just above the coal in most places. This material is removed as a "draw slate" in mining. The "white top" is fairly soft and contains a little sand and a few concretions scattered through the lower 2 feet, whereas the black shale is very hard and sheety.

At mine No. 1 of the Moffatt Coal Company the limestone cap rock is 35 feet thick, the main ledge of which is about 6 feet in thickness and not more than 4 feet above the coal. Where the limestone is not in contact with the coal, the intervening space is occupied by black or gray shale. Between the limestone and the coal, or between the limestone and the black shale, there is in most places a carbonaceous, limy shale which is very hard when fresh, but slacks quickly on exposure to the air. It averages 4 inches in thickness and is known to reach 12 inches in places.

In the mines of Washington County a few feet of gray or black shale forms the regular roof with a cap rock of limestone. At mine No. 5 of the Centralia Coal Company from 9 to 14 inches of top coal is left for roof while going forward, but between the coal and the limestone three different kinds of roof are found. Figure 36 illustrates the occurrence of the ordinary black shale in the eroded areas of which the gray shale or "white top" has been deposited. It also shows the contact of the cap rock with the coal, no shales intervening. Along such a contact the lower part of the limestone is generally impure and poorly bedded. Where the distance between the cap rock and the coal is small the shale is practically a draw slate which must be removed in mining.

It is said by the miner that the coal is thickest under the "white top". If this is true, it is probably because none of the top vegetal matter was mixed with the gray sediment as it was with the "black top."

Over the entire region treated in this chapter, the floor is a clay of variable thickness and character. In Perry County it has been found to range from a few inches to 8 feet or more. In the Paradise mine it is generally less than 3 feet in thickness, and it rests on a light-gray, compact limestone. It has a marked tendency to heave. In the different mines of the county the floor varies from a soft, plastic clay to a hard, sandy material containing pebbles or bowlders, especially in its lower part. In many places the records show the presence of a thin limestone beneath the floor clay, and here and there the coal rests on the limestone.

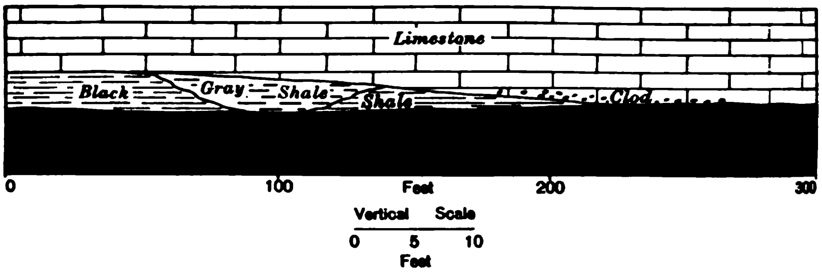

FIG. 36.—Roof conditions in Centralia Coal Co., mine No. 5, Centralia. (diagrammatic.)

The greatest irregularity in the floor is noted at Nashville, Washington County, where a thin coal from 18 inches to 2 feet thick is present only 2 or 3 feet below the coal, the lower bed resting on a variable amount of clay, generally less than 3 feet in thickness, and the latter underlain by limestone.

Besides the non-uniformity of the roof materials as described above, structural irregularities such as faults, rolls, and slickensides render mining more difficult. It is not uncommon in this region to find the roof filled with slickensided planes, the result of adjustments coincident with slightly irregular settling. These slips are most likely to occur in the gray shale, and in many places they do not extend downward into the coal. In some areas the slips run parallel to one another in certain directions, and the roof falls in wedge-like masses. At Moffatt Coal Company's mine No. 1, Sparta, the limestone is affected and falls in masses similar in shape to the shale wedges, a condition somewhat unusual. In other places some of the slips extend downward into the coal but not through it, and it is plain that unequal strain has simply forced a small part of the roof downward into the coal, and the resulting structure is known as a "roll". If the strain is sufficiently great the entire bed is fractured and displaced. No regularity is discernible in the rolls and prediction of their presence is impossible.

Numerous small faults are encountered throughout the area, the throw amounting to only a few feet. The greater number of these displacements is east of the Duquoin fold along the steep eastward dip. They are well shown in the Paradise and Majestic mines where they run slightly northeast-southwest. The largest fault at Paradise was found on the main west entry. It is a step fault with a downthrow of at least 20 feet towards the west. The exact amount could not be measured at the time of examination. It is probable that this is the fault the continuation of which was found in the Majestic mine.

The presence of stringers of coal in the overlying shale is another cause of roof trouble in parts of Perry County. They have been noted only in the vicinity of Duquoin, being especially developed in the Horn and Paradise mines. Figures 37, 38, 39, 40 and 41

FIG. 37.—Coal stringer, Brilliant Coal and Coke Co., Horn mine, Duquoin (West plug 6th N., 4700 feet from shaft.)

show typical stringers covering lenticular masses of roof shale as sketched in the mines mentioned. Almost every stringer is somewhere joined to the main coal; in other words, they are not later deposits. In this area most individual stringers do not exceed 1 foot in thickness, whereas most of them range from a mere streak to a few inches. Ordinarily a single stringer cannot be traced more than 20 or 30 feet along an entry. Considered in their entirety, they are thin layers of coal at the top of the bed, separated in places from the main coal by an irregularly shaped, lenticular mass of material similar to the roof shale. In the vicinity of the larger lenses, small movement planes may be found in the coal below, and slickensides are noticeable along the contact of the shale and coal. T. E. Savage[7] regards them

[7]Savage, T. E., Econ. Geol, vol. 2, p. 178.

as having been formed by unequal settling of the coal and roof material where the latter is capable of flowage in the geological sense, in order to adjust unequal strains.

It is not regarded advisable here to discuss at length the possible modes of origin of the lenses. In a general way they appear to be due to peculiar conditions of sedimentation at the close of the period that

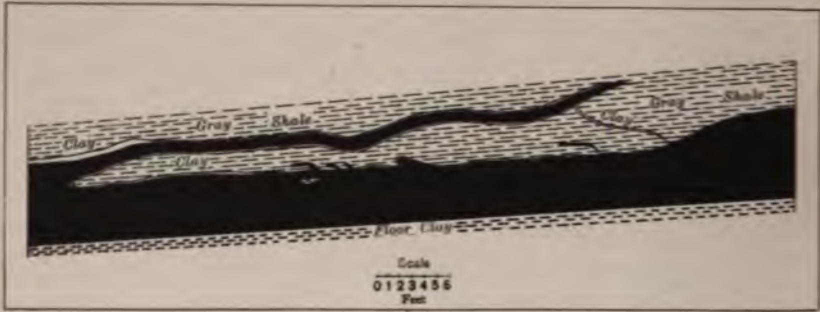

FIG. 38.—Coal stringer, Brilliant Coal & Coke Co., Horn mine, Duquoin. (7th. W.-N., 2700 feet from shaft.)

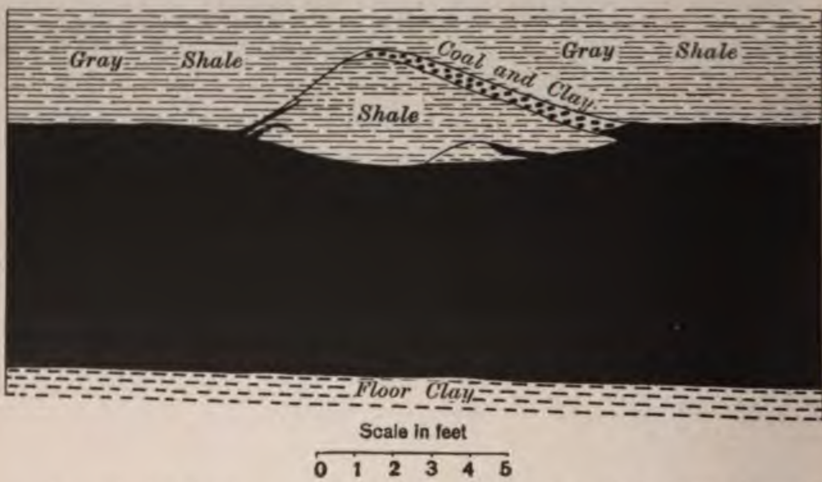

FIG. 39.—Coal stringer, Brilliant Coal & Coke Co., Horn mine, Duquoin. (7th west, north entry.)

produced the vegetal matter for coal No. 6. In comparatively small areas after the incursion of slowly moving waters bearing fine sediment and filling therewith many of the hollows at the surface of the coal swamp, a period ensued during which vegetal matter, fallen or transported, covered to varying depths many of the depressions that *had previously* been filled with sediment. Subsidence of the swamps

permitted the deposition of the main mass of roof material, and the later adjustments as evidenced by the slickensides appear to have resulted from the wide difference in the compressibility of shale and vegetal matter by the weight of the overburden.

Fig. 40.—Coal stringer, Paradise Coal Co., Paradise mine, Duquoin. (Main west entry, 2000 feet from shaft.)

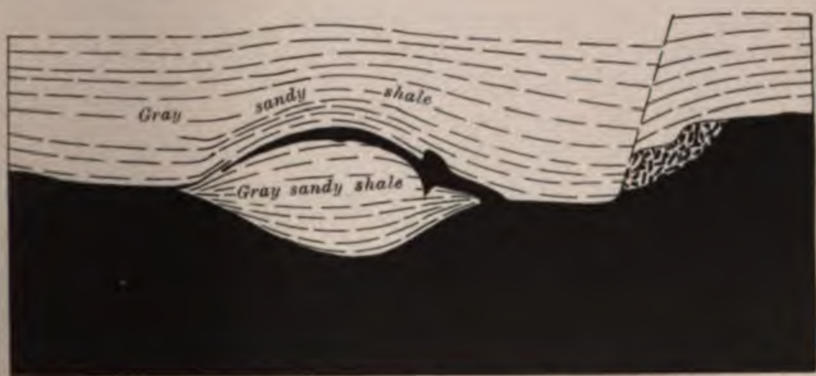

Fig. 41.—Small coal stringer, Paradise Coal Co., Paradise mine, Duquoin (150 feet from stringer shown in fig. 41.)

The lenses have but little effect on the quantity of minable coal, but their deleterious influence on the roof renders them troublesome features. Dangerous falls are numerous because the "slip" planes in the lenses and in many places along the coal stringers destroy any cohesion inherent in the shale, and it falls unexpectedly when the coal is mined, unless much careful timbering is done.

Other Coals

Except the outcrop of the lower coals at the south, information regarding their existence, thickness, and character must be gained from drill-hole records. In the early years of settlement and before

any large demand for coal existed, two or three of the thin beds above coal No. 6 were mined by drifts along the outcrop. A. H. Worthen mentions the highest coal in Washington County not far southeast of Ashley. It is only one foot thick and is of course commercially unimportant.

The next consistent bed is found 15 to 50 feet below the Shoal Creek limestone, and it does not generally exceed 14 inches in thickness. The following list of exposures of coal No. 9 is quoted from Worthen. "It is exposed on the Okaw River in the southeast quarter of section 1, township 1, range 6; and was found in the trial shaft four miles west of Nashville in the southeast quarter of section 17, township 2, range 3; also in the Nashville shaft in the southeast quarter of section 13, township 2, range 3; then on the upper course of a branch in the southwest quarter, corner of section 5, township 3, range 2; on Beaucoup Creek, and also on a branch in the southwest quarter of section 35, township 2, range 2; and near Little Muddy Creek in the north part of section 21, township 3, range 1 W". Although it is not a commercial bed, it is a good horizon marker a short distance below the limestone.

A thin bed, coal No. 8, generally a few inches thick lies in places about 180 feet above coal No. 6, and coal No. 7 is usually developed 30 to 50 feet above coal No. 6. It is in most places too thin to be commercial, although some drillers report it 3 or 4 feet thick. Most of these holes were made by the churn drill for oil, and it is believed that coal No. 7 does not average more than 1 foot in thickness; for this reason is not regarded an important possibility as a commercial coal bed.

Along the outcrop in Randolph County, coal No. 5 is found 40 to 60 feet below coal No. 6 and has an average thickness of about 3 feet. Several records from wells in the vicinity of the Sparta oil field show three coals within 100 feet below coal No. 6, the first being about 4 feet thick and 20 feet below the Belleville coal; the second, 2 to 4 feet thick and 40 feet lower; and the third, 3 feet thick and slightly more than 30 feet below the last. It is believed that the bed 40 feet below coal No. 6 represents coal No. 5 and the others are apparently local developments which are not traceable throughout the northeast part of the county. It is thought highly probable that at least one coal bed exists below coal No. 6 sufficiently thick to render it valuable in the future when the main coal is extracted. It is reported in only one hole drilled for water at Baldwin. At this place it was found at a depth of 300 feet practically 250 feet below coal No. 6 and is developed to a thickness of 4½ feet. Careful diamond drilling may yet

disclose the existence of coal No. 2 underlying the northeast part of the county.

In Washington County only a few logs record coal below No. 6. In the Finke well, sec. 12, T. 2 S., R. 3 W., a 5-foot bed is reported about 105 feet below coal No. 6. The Shoup well in sec. 14, T. 3 S., R. 4 W. penetrates coal No. 5, 3 feet thick, at a depth of 300 feet, 70 feet below coal No. 6. It is not likely that these two beds are the same, since the interval between them and coal No. 6 is so different. It is probable that lenses of coal below No. 6 exist in Washington County, and that future drilling will develop areas suitable for exploitation. With the present information, however, any estimate of the areal distribution of such coals would be worthless.

Of all the drill holes in Perry County, only 9 of those in possession of the survey record coals below No. 6. Most of the holes are stopped at the horizon of coal No. 6, and in some of the oil holes no coals are recorded, the absence being due no doubt to carelessness in noting the drillings from the upper part of the well.

In the vicinity of Pinckneyville and southwest of this place on Galum Creek, a few holes record a coal 25 to 30 feet below coal No. 6. The bed varies considerably in thickness, but in places it is known to be more than 4 feet. It is probable that this bed represents the Harrisburg (No. 5) coal, although the interval between it and coal No. 6 is smaller than normal. About 250 feet below coal No. 6, a single bed, or in places two beds close together, are reported in a majority of the holes. It is reported to vary from a foot or two to almost 5 feet, and its persistent development renders it a promising bed for prospecting. Several lenticular beds between 2 and 6 feet thick are reported, and it is not always possible to correlate the continuous beds correctly. In the record given below, coal No. 2 may be represented by the 3-foot 5-inch bed 220 feet below coal No. 6 or by the thin beds, the topmost of which lies 244 feet below No. 6.

Record of drill hole

Location—Galum Creek, Perry County, on line of W. C. & W. R. R., July, '87

Description of Strata	Thickness		Depth	
	Ft	*In*	*Ft.*	*In*
Surface soil	17	6	17	6
Shale, black	1	10	19	4
Limestone, dark blue	8	8	28	
"Slate", black	2	6	30	6
Coal (No. 6)	5	10	36	4
Fire clay	1	6	37	10
Limestone	1	3	39	1
Shale, soft, white	2	3	41	4
Limestone, *light gray*	2		43	4

Description of Strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Shale, sandy	7	10	51	2
Limestone, hard, white	6	7	57	9
Shale hard, gray	2	..	59	9
Limestone, hard, blue	..	6	60	3
Coal (No. 5)	4	8	64	11
Fire clay	11	1	76	..
Limestone	..	9	76	9
Shale	2	..	78	9
Shales, sandy with a little sandstone	40	1	118	10
Shales, sandy	12	6	131	4
Shales, blue with limestone nodules	5	3	136	7
Limestone	1	4	137	11
"Slate", black	8	3	146	2
Coal	3	1	149	3
"Soapstone", gray	1	8	150	11
Coal	..	2	151	1
Shales, dark, with sulphur nodules	2	4	153	5
Shales, gray, with iron pyrites	..	9	154	2
Shale, gray	..	10	155	..
Shale, black, with limestone nodules	6	2	161	2
Limestone	..	1	161	3
Shales	13	10	175	1
"Slate", black	2	9	177	10
Coal	2	2	180	..
"Slate", dark gray	1	11	181	11
Shales, gray with sulphur	6	7	188	6
Limestone	..	7	189	1
Rock, hard, brown	..	2	189	3
Shale, green	..	9	190	..
Shales, sandy, and sandstone	3	..	193	..
Shales, with 4 inches sandstone and 4 inches limestone	15	4	208	4
Limestone, brown	..	3	208	7
Shales	9	8	218	3
Coal	1	6	219	9
Shales, green, clay	..	6	220	3
Limestone	..	11	221	2
Coal	2	6	223	8
Fire clay	1	7	225	3
Shale, gray	..	8	225	11
Limestone, sandy	..	8	226	7
Shale, gray, with limestone nodules	..	9	227	4
Shale, dark	..	5	227	9
Coal, soft, and rock mixed	..	9	228	6
Shales, brown and gray, with limestone nodules	7	6	236	..
Shales	12	9	248	9
Sandstone	4	6	253	3
"Slate", black with sulphur	1	7	254	10

Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
Shales, black with fossils	..	4	255	2
Coal	3	5	258	7
"Slate", black	..	5	259	..
Shales, dark, sandy	8	7	267	7
Shale, gray, with limestone nodules	1	9	269	4
Shale, hard, gray	5	11	275	3
Rock, hard	..	1	275	4
Shale	..	10	276	2
Rock, hard	..	3	276	5
Shale, dark, gray	6	3	282	3
Coal	1	7	283	10
Shale, dark, with limestone nodules	2	2	286	..
Shales, sandy and gray	6	9	292	9
"Slate" and coal mixed	..	1	292	10
Shales	5	..	297	10
Coal and slate mixed	..	4	298	2
Shales	28	9	326	11
Sandstone, white, with thin coal seams	1	..	327	11
Millstone grit	14	8	342	7
Sandstone, pebble	1	..	343	7

The following table shows the location of holes in Perry County that have penetrated coals below No. 6.

TABLE 15.—*Position and thicknesses of coals below coal No. 6 in Perry County*

Location ¼	¼	Sec.	T. S.	R. W.	Depth below No. 6 coal	Thickness Ft.	In.	Coal bed
					Feet			
		25	4	4	110	2	4	
		35	5	4	24	4	8	No. 5
					110	3	1	
					141	2	1	
					181	1	6	
					185	2	6	
					219	3	5	
					246	1	7	No. 2?
..	NE	3	6	2	116	2	..	
					233	3	..	No. 2
..	NE	3	6	2	233	3	..	No 2
..	NE	18	6	2	120±	1	7	
					240±	3	.	No. 2
SE	SW	19	6	2	235±	4	7	No. 2
NW	SW	17	6	3	224	5±.		No. 2

From the material available for study it seems certain that coal No. 5 underlies at least parts of Perry County in workable thickness. Since it lies within 50 or 60 feet below coal No. 6, the extra drilling should always be done to determine the thickness and character of the lower bed.

It is almost certain that at least some coal exists at the horizon of coal No. 2, and its high quality in the Murphysboro district will later stimulate prospecting for it in Perry County. Careful drilling will probably outline areas in which it will be commercial, but such explorations will probably not be be undertaken until coal No. 6 has largely been removed.

SHELBY AND MOULTRIE COUNTIES

Production and Mines

SHELBY

Production in tons for year ended June 30, 1913....	202,968
Average annual production, 1909 to 1913........	89,868
Total production, 1881 to 1913..................	1,989,116

MOULTRIE

Production in tons, year ended June 30, 1913.....	105,280[a]
Total production to 1912......................	181,335

Shelby and Moultrie counties are not large producers of coal. During the year ended June 30, 1913, Shelby County's output was 3/10 of 1 per cent of that for Illinois, and Moultrie mined only a little more than half as much. The lack of large mining operations is due in large part to the great depth of coal No. 6 which lies from 600 to 900 feet below the surface in these counties. Moreover, the coal does not underlie the entire area, and investors hesitate to spend large sums in testing deep territory as long as any shallower coal is available. In the future when the coal nearer the surface becomes scarce, drilling and mining operations will be pushed eastward into parts of Moultrie County. At present Tower Hill Coal Company No. 1, at Tower Hill, and Lovington Coal Mining Company, No. 1 at Lovington, are the only mines operating coal No. 6 in the two counties. In Shelby County coal No. 5, the Springfield bed, is mined at Moweaqua, and a 2-foot bed lying from 50 to 160 feet below the surface and about 700 feet above coal No. 6 is being mined in a small way in the vicinity of Shelbyville. Worthen mentions early mining from this bed which he calls coal No. 15, or the "Shelby Coal", and also from

[a]*Lovington Coal Mining Company No. 1, the only mine in Moultrie County, began to produce in 1909.*

his coal No. 14, which varies in thickness from 16 to 22 inches. The latter was worked formerly in the south part of sec. 15, T. 9 N., R. 1 W. It lies a few feet above the New Haven limestone; whereas the coal now being worked is 100 to 120 feet above this horizon.

Below is a list of shipping mines in the two counties.

TABLE 16.—*List of shipping mines, Shelby and Moultrie counties, 1913*

Map No.	Company	Mine	Coal bed	Location ¼	¼	Sec.	T. N.	R. E.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness Ft.	In.	Production 1913
									Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
	Shelby County—													
1	Tower Hill Coal Co.	1	6	NW	NW	23	11	2	665	798	133	7	..	145,756
2	Moweaqua Coal Mining & Mfg. Co.	1	5		NW	31	14	2	635	620	15	5	4	49,813
			6			..	..	..	...	580	55	5	7	......
	Moultrie County—													
1	Lovington Coal Co.	1	6	NE	SE	27	15	5	680	904	-224	8	..	105,280

COAL-BEARING ROCKS

Eighteen logs available for study in Shelby County and two in Moultrie show a remarkable similarity, especially since they were obtained from various sources. About 1450 feet of "Coal Measures" rocks are known from drill records, and it is likely that a somewhat greater thickness exists along the eastern border of these counties.

The most striking characteristics of the logs when plotted by symbols and placed side by side are coals No. 6 and No. 7 and associated limestones between 700 and 800 feet below the surface, a group of thin limestones 250 to 300 feet above coal No. 6, representing the Carlinville and Shoal Creek, and another thick limestone 200 to 250 feet above the latter and regarded as the New Haven. The latter is regularly developed to a thickness of 20 to 50 feet in every log studied from the two counties. Very little sandstone exists above coal No. 6. Below this coal the logs are much less regular. No distinct limestones or sandstones are traceable throughout the area, but in a general way the beds are more sandy. Lenticular coals are noted especially at the horizons of coals No. 5 and No. 2, although only a few of the logs record such beds.

Lying beneath the "Coal Measures" are the interbedded limestones, sandstones, and red shales of the Chester. In drilling for coal it is not necessary to penetrate all of the "Coal Measures" rocks, since all the important beds lie within 300 feet below coal No. 6.

The following logs will aid the driller in identifying the beds in Shelby and Moultrie counties.

Drill record of H. L. Hargrave

Farm—T. Vidler

Location—Sec. 8, T. 10 N., R. 1 E.

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Clay, hard, and pebbles	17	..	17	..
Sand, gravel, clay	14	..	31	..
Clay, dark	55	6	86	6
Shale, lime	1	..	87	6
"Slate"	..	6	88	..
Coal	1	..	89	..
Drift	5	..	94	..
Shale, lime	7	..	101	..
Shale, blue	3	..	104	..
Limestone (New Haven)	37	..	141	..
Sandstone, soft	6	..	147	..
Shale, dark, sandy	17	..	164	..
Shale, dark	59	..	223	..
Coal	1	..	224	..
Shale, gray	11	..	235	..
Shale, brown	4	..	239	..
Shale, blue	9	..	248	..
Shale, dark	22	..	270	..
"Slate", black	2	..	272	..
Coal	1	..	273	..
Shale, blue	18	..	291	..
Shale, dark	4	..	295	..
Sandstone, hard	3	..	298	..
Shale, dark, sandy	24	..	322	..
Shale, dark, with limestone bands	8	..	330	..
Shale, dark	17	..	347	..
Shale, black	1	..	348	..
Shale, blue	8	..	356	..
Shale, blue, with limestone bands	3	..	359	..
Shale, blue	13	..	372	..
Limestone (Shoal Creek)	14	..	386	..
Shale, dark	1	..	387	..
"Slate", black	3	6	390	6
Shale, brown	3	6	394	..
Shale, dark	7	..	401	..
Coal	1	..	402	..
Shale, dark	2	..	404	..

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
"Soapstone", light	13	..	417	..
Shale, dark	9	..	426	..
"Slate", black	5	..	431	..
Limestone (Carlinville?) and lime shale	22	..	453	..
Shale, hard	28	..	481	..
Shale, soft	45	..	526	..
Coal (No. 8)	..	6	526	6
Fire clay, soft, white	1	6	528	..
Shale, light	1	..	529	..
Sandstone	3	..	532	..
Shale, light, sandy	8	..	540	..
Shale, dark	77	..	617	..
Shale, very dark	4	..	621	..
Shale, light blue	3	..	624	..
Shale, blue, with limestone bands	2	..	626	..
Shale, blue	4	..	630	..
Shale, soft, black	2	..	632	..
Shale, dark	5	6	637	6
Limestone	6	6	644	..
Shale, dark blue and yellow	2	.	646	..
Shale, dark	4	..	650	..
Shale, red	..	6	650	6
Shale, blue	1	6	652	..
Shale, black	4	.	656	
Limestone and shale	2	..	658	.
Shale, blue	4	8	662	8
Coal (No 7)	3	6	666	2
Shale, blue	1	1	667	3
Limestone, soft	4	11	672	2
Shale, hard, black	2	1	674	3
"Slate", black	..	9	675	..
Shale, blue	1	..	676	
Shale, sandy, lime	2	9	678	9
Shale, blue	1	6	680	3
Limestone	1	4	681	7
Shale, blue	..	8	682	3
Limestone	..	11	683	2
Shale, soft, dark	..	10	684	
Shale, hard, dark	3		687	
Limestone	2	.	689	.
Shale, dark	1		690	
"Slate", black	2	4	692	4
Coal (No. 6)	6	6	698	10
Fire clay, hard				

Record of Shelby Coal, Oil, and Natural Gas Co. well
Location—Shelbyville

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Clay and bowlder	19	..	19	..
Shale, blue	20	5	39	5
Coal	1	1	40	6
Fire clay	3	6	44	..
"Soapstone"	12	..	56	..
Sandstone	1	..	57	..
"Soapstone", gray	3	..	60	..
Shale, sandstone	30	..	90	..
Shale, blue	8	6	98	6
Shale, bituminous	1	6	100	..
Coal (mined at Shelbyville)	..	10	100	10
Fire clay	1	2	102	..
Shale, gray	7	..	109	..
Sandstone, hard	4	..	113	..
Shale, sandstone	14	5	127	5
Coal conglomerate	..	2	127	7
Shale, gray	2	5	130	..
Shale with sandstone partings	9	..	139	..
Sandstone	3	..	142	..
Shale, blue	19	..	161	..
Shale, fossil	..	9	161	9
Coal	..	9	162	6
Shale, clay	10	..	173	6
Limestone (New Haven)	7	..	180	6
Shale, clay	3	..	183	6
Limestone	5	..	185	6
Limestone	29	6	215	..
Shale, blue	18	6	233	6
Shale, blue	36	..	269	6
Sandstone	5	..	274	6
Shale, blue	10	6	285	..
Coal	..	6	285	6
Shale, clay	5	..	290	6
Sandstone	9	..	299	6
Shale, gray	5	..	304	6
Shale, clay, and limestone beds	5	..	309	6
Shale, clay	6	..	315	6
Shale, bituminous, black	21	..	336	6
Rock, fossil	2	6	339	..
Coal	..	10	339	10
Fire clay	1	8	341	6
Shale, clay	10	..	351	6
Sandstone	7	..	358	6
Shale, sandstone	11	..	369	6
Shale and sandstone partings	15	..	384	6
Shale, black	1	..	385	6
Coal	1	2	386	8

Description of Strata	Thickness		Depth	
	Ft.	In.	Ft.	In.
Shale, black	6	10	393	6
Fire clay	4	..	397	6
Limestone	1	..	398	6
Shale, gray	9	..	407	6
Sandstone	5	..	412	6
Limestone (Shoal Creek)	10	6	423	..
Shale, black	1	6	424	6
Coal	..	2	424	8
Shale, clay	10	10	435	6
Sandstone	4	..	439	6
Limestone	1	6	441	..
Shale, gray	4	6	445	6
Shale, gray	22	..	467	6
Shale, gray	4	..	471	6
Shale, fossil	2	..	473	6
Fire clay	6	..	479	6
Shale, black	4	..	483	6
Sandstone	6	..	489	6
Shale, sandstone	25	..	514	6
Shale, blue	21	..	535	6
Shale, black	1	..	536	6
Shale, blue	6	..	542	6
Rock, fossil		10	543	4
Shale, black	1	.	544	4
Coal (No. 8)	.	6	544	10
Fire clay	2	8	547	6
Shale, gray	15	..	562	6
Shale, blue	10	..	572	10
Limestone	9	..	581	10
Shale, blue	2	6	584	4
Limestone	5	6	589	10
Shale, gray	3	.	592	10
Shale, striped	7	.	599	10
Shale, blue	10	.	609	10
Shale, gray	26		635	10
Coal	3	.	638	10
"Slate," clay	8	.	646	10
Limestone	3	.	649	10
Shale, gray	25		674	10
Shale, sandstone	15	.	689	10
Shale with sandstone partings	10		699	10
Sandstone	3		702	10
Shale, sandstone	2		704	10
Sandstone	8		712	10
Shale, sandstone	10	.	722	10
Sandstone	22	11	745	9
Coal (No. 6)	1	1	746	10
Sandstone with coal	1		747	10
Sandstone, soft	15	.	762	10

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Sandstone	69	10	832	8
Sandstone (coal partings)	..	1	832	9
Sandstone	17	1	849	10
Sandstone	29	9	879	7
Coal	..	1	879	8
Shale, sandstone	2	2	881	10
Shale, gray	16	..	897	10
Shale, black	7	8	905	6
Coal	1	4	906	10
Shale, sandstone	1	6	908	4
Sandstone	9	6	917	10
Shale, sandstone	19	..	936	10
Shale, black	2	..	938	10
Coal	..	9	939	7
Sandstone (?)	15	3	954	10
Shale, sandstone	24	..	978	10
Shale, blue	3	8	982	6
Shale, bituminous	1	6	984	..
Coal (No. 2?)	2	10	986	10
Shale, blue	2	..	988	10
Sandstone (?)	6	..	994	10
Shale, black	3	..	997	10
Shale, blue	2	..	999	10
Coal	..	8	1000	6
Shale, clay	1	4	1001	10
Shale, blue	8	5	1010	3
Coal (No. 2?)	3	8	1013	11
Fire clay	1	3	1015	2
Sandstone	2	..	1017	2
Shale, gray	4	..	1021	2
Limestone	2	10	1024	..
Shale, black	..	2	1024	2
Shale, gray	6	6	1030	8
Shale, black	2	6	1033	2
Coal	..	1	1033	3
Shale, clay	6	6	1039	9
Limestone	1	6	1041	3
Shale, gray	6	..	1047	3
Limestone, bastard	2	..	1049	3
Shale, bituminous	3	..	1052	3
Shale, black	4	..	1056	3
Shale, sandstone	7	..	1063	3
Shale, gray	3	..	1066	3
Coal (No. 1?)	2	9	1069	..
Fire clay	1	..	1070	..
Shale, gray	11	..	1081	..
Shale, black	4	..	1085	..
Limestone, fossil	1	..	1086	..
Coal	1	9	1087	9

Description of Strata	Thickness		Depth	
	Ft.	*In.*	*Ft.*	*In.*
Fire clay	3	3	1091	..
Shale, black	1	10	1092	10
Coal	1	2	1094	..
Fire clay	4	..	1098	..
Shale, clay	9	..	1107	..
Coal	1	9	1108	9
Shale, gray	12	9	1121	6
Shale, blue	37	9	1158	3
Coal	..	3	1158	6
Sandstone	8	..	1166	6
Shale	5	..	1171	6

The 3-foot coal 106 feet above the horizon of coal No. 6 is not in proper position for coal No. 7, and it appears to be a small lens. It is possible that this bed does represent coal No. 7, since wherever it appears too high in the section, coal No. 6 is either thin or absent, due to erosion or to some condition which prevented regular deposition and it is scarcely to be expected that the intervals between 6 and adjacent beds will be regular.

The limestone cap rock of coal No. 6 is not present, a fact which argues for erosive action, and the coal itself is represented by only 13 inches. Coal No. 2 is probably represented by the 2-foot 10-inch bed at a depth of 986, or by the 3-foot 8-inch bed at 1009, and coal No. 1 is found at 1065 having a thickness of 2 feet 9 inches. The lower coals are not reported in any of the other logs, and it is likely they are small lenses. It is believed that the so called 8-foot coal at the bottom of the hole is really a black shale since no such coal is known in any other part of the State.

Geologic Structure

The geologic structure of the beds in Shelby and Moultrie counties is not known in detail. The holes are confined to the southern half of Shelby and the town of Lovington in Moultrie, and they are so scattered over the area that postulation of detailed structure is impossible.

In the northwestern part of Shelby County, at Moweaqua coal No. 6 lies 55 feet above sea level; whereas at Lovington 22 miles slightly north of east the same bed is 209 feet below sea level, a condition indicating a dip of 12 feet per mile. Along an east-west line from Pana, Christian County, to Shelbyville the coal dips east at the rate of about 10 feet per mile. In the southeast part of the County, however, there are two holes in which coal No. 6 is higher than at Shelbyville. In sec. 24, T. 10 N., R. 4 E. the coal is about 70 feet

higher than at Shelbyville, although if regular dips prevailed, it would be somewhat lower. About 8½ miles east of the last hole mentioned is another in which the horizon of coal No. 6 is 35 feet higher than in the first. The eastern part of Shelby lies in the trough that runs parallel to the La Salle anticline on the west. The dip of the beds in this part of the county is apparently to the west. The position of the coal in the few wells available for study points to the fact that the lower part of the Illinois coal basin undulates, and that small folds of different types may be expected. Again it may be true that the axis of the trough may not be parallel to the La Salle anticline, but may run slightly east of north. The strike of the beds is represented by a line connecting Shelbyville and Lovington at each of which the coal lies practically 200 feet below sea level. The fact that the coal is only 40 feet below sea level in sec. 24, T. 6 N., R. 2 W., Fayette County, seems to indicate that an east-west anticline the axis of which lies in T. 10 N. separates synclinal basins on the north and south, all these features being parts of the general trough-like basin.

Coal No. 6

Distribution and Thickness

The holes that have been drilled in Shelby County lie south of a line drawn east and west through Shelbyville. The logs indicate that the south boundary of the area in which coal No. 6 is thin or absent as shown in Christian County continues eastward into Shelby and extends east and south toward the southeast corner of the county. Its exact position between Tower Hill and Shelbyville is unknown. It is believed that the largest block of coal No. 6 exists in the following townships:

T. 9 N., Rs. 1, 2, 3, 4, and northwestern part of 5 E.
T. 10 N., Rs. 1, 2, 3, 4, and western part of 5 E.
T. 11 N., Rs. 2 and south ½ of 3 E.

Coal No. 6 is either absent or too thin to be commercial in the vicinity of Shelbyville, which lies near the southern boundary of the ancient drainage area. The northern boundary of this area enters Shelby County a short distance northeast of Assumption but cannot be traced because of meager information. Coal No. 6 is known to exist at Moweaqua in the northwest corner of the county where it is 5 feet 7 inches thick but at this place coal No. 5 (Springfield coal) is mined. No holes have been drilled east of Moweaqua. It is possible that this barren area connects with the eroded crest of the La Salle ticline but no proof is available at this time.

Throughout the townships listed above, coal No. 6 averages about *feet in thickness.* At Tower Hill mine the bed is somewhat

thicker and probably averages 7 feet. The only information regarding coal No. 6 in Moultrie County is derived from the Lovington mine and two nearby drill holes. At the mine the coal varies in thickness from 4 to 9½ feet, the average being 8 feet. It seems probable that the Lovington coal lies on the north side of the wide erosion area described earlier in this chapter, and that this is a local thickening of the coal. The mine is located on the north boundary of the area in which coal No. 6 is workable, and the variability in thickness is due probably to its proximity to the edge of the ancient swamp. Whether a solid block of coal underlies the surface from Lovington west to Moweaqua and Blue Mound is uncertain; but there is little doubt that if such a connected coal exists, it does not attain so great a thickness as at Lovington.

PHYSICAL CHARACTER

Coal No. 6 has been seen in only two mines, Tower Hill and Lovington. At the former the average thickness is a little more than 7 feet. Figure 42 shows graphically the physical character of coal No. 6

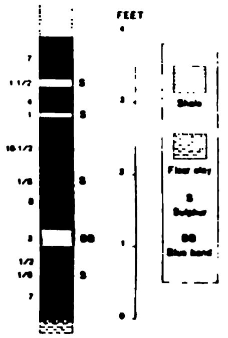

FIG. 42.—Graphic section of coal No. 6 in Shelby County. Tower Hill Coal Co., mine No. 1, Tower Hill.

in Shelby County. The top coal about 16 inches thick is the best; the middle bench contains a number of pyrite bands some of which are 1½ inches thick. The "blue band," which is only about 12 inches from the floor, is thicker than usual, three inches of it having been measured in one section of the mine where it was overlain by 6 or 8 inches of more or less impure coal. In a few places small clay seams varying from 1 to 12 inches in thickness extend 2 or 3 feet into the coal from the top, but rarely cut the entire bed.

At Lovington the top coal is about 30 inches thick in parts of the mine, and the "blue band" lies as much as 24 inches above the floor where the bed is thickest. Figure 43 shows the physical character of

coal No. 6 in parts of Moultrie County. The middle bench contains a number of pyrite bands varying in width from a mere streak to about 1 inch. About 300 feet south of the shaft on the main entry the bed measures 9 feet 4 inches in thickness which is 2 feet in excess of the average for district VII.

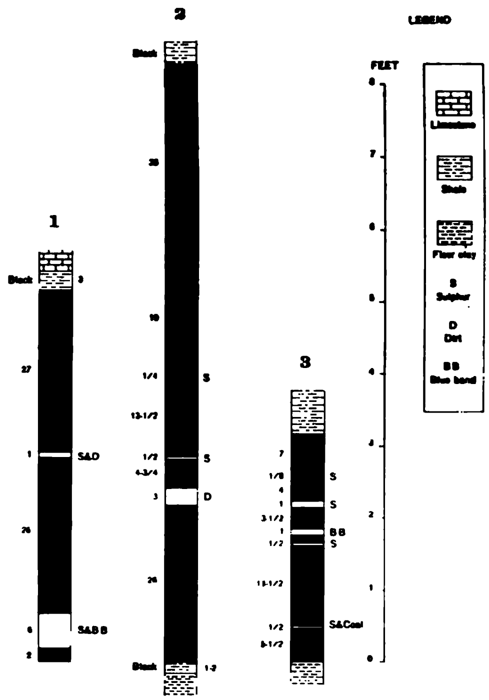

FIG. 43.—Graphic sections of coal No. 6 in Moultrie County. Lovington Coal Mining Co., Lovington.

1. Cross-cut between man-way and air-way.
2. Room 1, back south entry.
3. Main south entry, 300 feet from shaft.

ROOF AND FLOOR

Where coal No. 6 exists in its normal thickness, the regular succession of shale and limestone roof materials is present, but in the area where the coal is reduced in thickness, as at Shelbyville, the roof has also been affected. In most of the holes located north and east of the line representing the approximate boundary between normal coal on the south and thin coal on the north, the roof consists of shale, sandstone, or a mixture of the two instead of the limestone. At Tower Hill the limestone lies on the coal in a few places, but over most of the mine shale attaining a thickness of 6 feet intervenes. It is also reported that above the regular top coal and separated from it

by a few inches of black shale, there is in places at Tower Hill a thin lenticular coal. Such a condition has also been noted at the new mine of the Nokomis Coal Company in Montgomery County. The roof at Lovington consists of about 2½ feet of shale overlain by 9 feet of limestone.

Fourteen feet of shale underlies coal No. 6 at Lovington, and below this a 4-foot coal is reported. Such a coal is not mentioned in the log of the shaft, and it is probably lenticular. At Tower Hill the underclay varies from 3 to 4 feet. No regular succession of beds exists below coal No. 6; some of the logs show limestone under the floor clay, but others show only shale or sandstone.

Coal No. 5

The only mine operating coal No. 5 in District VII is located at Moweaqua. This bed lies 40 feet below coal No. 6 which is 5 feet 7 inches thick. Coal No. 5 bears all of the characteristics of the same bed at Springfield. It averages 54 inches in thickness; is overlain by black shale, shaly limestone and gray shale in ascending order; and the coal itself has many clay veins. They vary in width from mere veinlets to several feet in size and consist of clays which have been forced downward into vertical fractures in the coal, as a result of unequal settling of the vegetal matter and its overburden. They will be discussed in detail in the report on District IV.

In different parts of Shelby County, logs show the existence of a somewhat persistent coal from 25 to 80 feet below coal No. 6, which is no doubt coal No. 5. Its thickness at Moweaqua and in some of the holes in the southwestern part of the county indicate that this bed may become very important in future years, especially in the northern part which really joins the Springfield area. The south boundary line of present commercial coal No. 5 probably passes east and west through the northern part of Shelby County a few miles south of Moweaqua. Whether or not thick coal No. 5 underlies Moultrie County is unknown. It is recommended that future drilling, especially with the core drill be continued at least 80 feet below coal No. 6, unless coal No. 5 is penetrated at less depth.

Other Coals

Mention has already been made of the Shelby coal called coal No. 15 by A. H. Worthen. It is now mined for local use to the extent of about 7500 tons yearly. It outcrops "on Copperas Creek and at several places above its mouth near Little Wabash River, at the water's edge near Shelbyville and occasionally for 10 miles south, on Richland Creek and its tributaries, on Robinson's Creek near the railroad,

above on Mud Creek and Brush Creek below Prairie Bird, and on Beck's Creek at the railroad." The Shelby coal varies in thickness from about 18 inches to 3 feet but is reported in the mines to average 2 feet.

In the vicinity of Shelbyville this coal lies from 50 to 160 feet below the surface and is about 700 feet above the horizon of coal No. 6 or from 100 to 120 feet above the limestone referred to the New Haven.

The present writer prefers the name Shelbyville coal for this bed since its correlation as coal No. 15 implies the existence of a number of persistent coals capable of being identified over large areas; whereas most of the beds between coal No. 6 and the coal at Shelbyville are only a few inches thick and not positively identifiable from one hole to another.

Seven holes in Shelby County have passed through the "Coal Measures", and three of them report a coal 3 to 4 feet thick 225 to 250 feet below coal No. 6, probably to be correlated with coal No. 2. From 60 to 100 feet lower two or three thinner beds are known occupying the position of coal No. 1. The uppermost of these beds at Shelbyville lies 1068 feet below the surface and attains a thickness of 2 feet 9 inches. Three other beds ranging in thickness from 1 foot 2 inches to 1 foot 9 inches and separated from each other by thin shales exist in a 40-foot zone of which the 2-foot 9-inch coal mentioned above is the top. At the time these beds were being deposited coal-forming conditions were interrupted by irregular periods in which the surface was sufficiently low to permit mud deposits. This alternation did not occur simultaneously over the area, and the result was a number of thin beds here and there, only three or four representing the same general period of coal deposition.

From meager data at hand regarding the earliest coal beds in this region, it is useless to attempt to outline their areal distribution, but later need will no doubt develop commercial areas of coal No. 2. Formerly the Moweaqua shaft was sunk to a depth of 924 feet and one of the lower beds, corresponding probably to coal No. 2 was worked for a short time, but was abandoned in favor of coal No. 5, 300 feet higher in the shaft.

SANGAMON COUNTY

Only the southern part of Sangamon County is treated in this report, the northern portion being included in District IV to be described in a later bulletin.

A northeast-southwest line, passing about 2 miles north of Chatham and extending towards Mechanicsburg, marks the northern limit

of the area in which coal No. 6 is sufficiently thick to be commercial. North of this line the position of which is shown approximately on the large map, the "blue-band" coal averages only a few inches in thickness and mining is confined to coal No. 5 which ranges in thickness from 5 to 6⅔ feet in the area of the Tallula-Springfield quadrangle.[9]

Production and Mines

Total production[10] coal No. 6, 1881-1913..........62,100,919

During the year ended June 30, 1913, six mines in the southern part of the county produced 2,036,002 tons of coal No. 6 or 3.28 per cent of the State's output. The average annual production of coal No. 6 from this county for the five-year period, 1909 to 1913 inclusive, was 1,624,984 tons. The following mines were operating coal No. 6 in 1913.

Table 17.—*List of shipping mines producing coal No. 6, Sangamon County, 1913*

Map No.	Company	Mine	Location ¼	Location ¼	Location Sec.	Location T. N.	Location R. W.	Surf. elev.	Depth to coal No. 6	Alt. top coal No. 6	Average thickness		Production 1913
								Feet	*Feet*	*Feet*	*Ft.*	*In.*	*Tons*
1	Chicago, Wilmington and Vermilion Coal Co.	1	SW	NW	34	13	6	648	293	355	6	8	551,787
2	Illinois Midland Coal Co.	5	SW	NE	12	13	5	628	322	306	6	..	488,445
3	Madison Coal Corporation	6	NE	SW	21	13	5	614	312	302	8	..	403,284
4	Black Diamond Coal Co.	Black Diamond		SW	15	13	6	628	301	327	7	.	368,907
5	Auburn and Alton Coal Co				10	13	6	628	264	364	7		112,554
	Lefton Coal Co				..	..	..	.	261	..	7		111,025

[9]Shaw, E. W., and Savage, T. E., U. S. Geol. Survey, Geol. Atlas, Tallula-Springfield folio (No. 188), p. 11, 1913.

[10]Estimated.

At the Auburn mine of the Black Diamond Coal company the top coal is left in place where the roof consists of black shale. At this mine the coal is said to vary in thickness from 4½ feet to 11 feet. The contact of the roof and the coal is irregular, due probably to the unevenness of the surface of the vegetal matter at the time the roof material was deposited.

ROOF AND FLOOR OF COAL NO. 6

The normal black shale-limestone roof of the Belleville district is typically developed in the mines of southern Sangamon County. The shale is extremely irregular in thickness being absent in some places and as much as 8 feet thick in others. Ordinarily where it is only a few inches thick it is necessary to leave the top coal in place in order to prevent the shale from falling. At Divernon 1 to 6 inches of clod underlies the black shale. A considerable area in the mine is affected by a depression in the coal which decreases the thickness of the bed to about one-half its normal amount. The depression extends north-

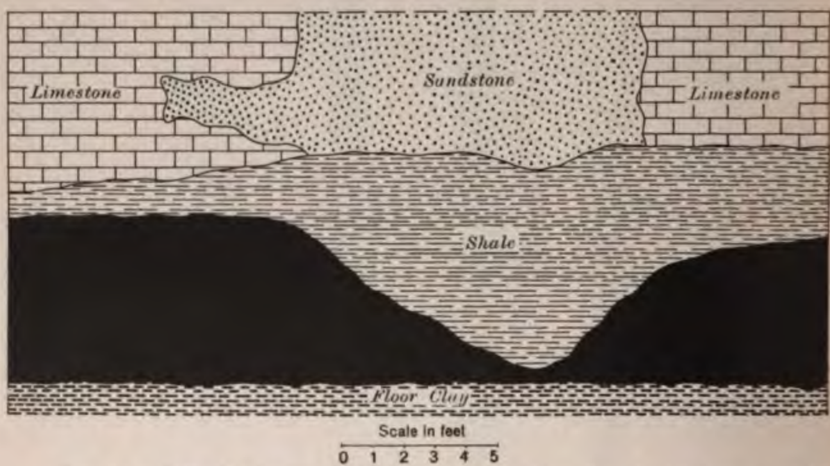

FIG. 45.—Roll, Madison Coal Corporation, mine No. 6, Divernon. (4th west, 7th north, west entry.)

east-southwest and has been traced about 900 feet. At the time of examination it was typically exposed in room 2, 4th west entry, 7th north, on the west side of the mine. In the depression, clod and limestone form the roof, the latter material being nodular, clayey, and full of concretions that fall easily and render the roof unsafe. In the area thus affected the coal is noticeably impure. Figure 45 shows a sandstone lens in the roof limestone and a roll cutting the coal down to a thickness of only 1 foot. The sandstone may occupy its present

position as the result of filling an erosion cavity or a cavity formed by solution of the limestone by acid waters as is often the case.

It is apparent that some erosion affected the black shale after deposition. In the Black Diamond mine very irregular contacts are noted between the cap rock and the shale as shown in figure 46.

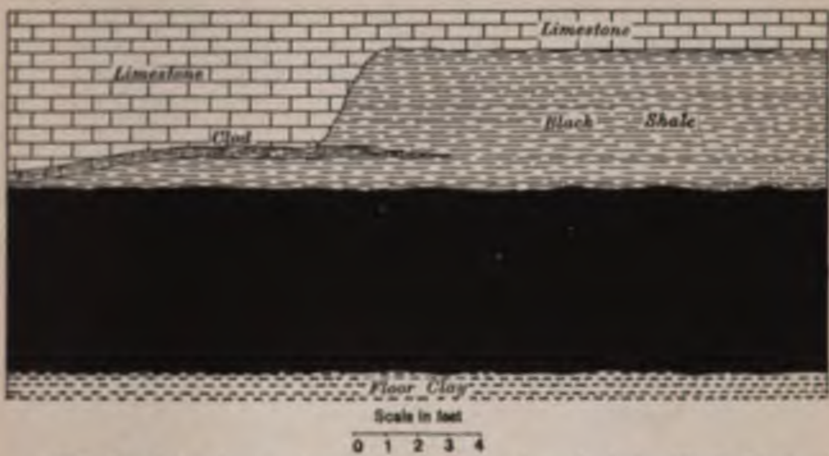

FIG. 46.—Irregular contact between cap rock and shale, Black Diamond Coal Co., Auburn.

The normal limestone roof is a dark gray, noncrystalline rock having well-developed cleavage planes. In this condition it is strong and forms an excellent roof. However, in places it is nodular, contains clay and niggerheads, and falls easily. At the face of the main south entry on the east side of this mine, limestone-shale and shale-coal contacts are very irregular. At this place the coal shows many small "slip" planes and is impure. See figure 47.

At the Thayer mine of the Chicago, Wilmington and Vermilion Coal Company, the normal roof is present except in one or two places where the black shale is only 6 inches thick and is overlain by 3 or 4 feet of light gray or yellow, sandy shale. From 4 to 8 inches of top coal is left ordinarily but is generally taken down after the rooms are mined out.

At the Victor mine of the Illinois Midland Coal Company a roll 100 feet wide intersects the workings in the shape of a horseshoe, the toe of the shoe pointing toward the shaft from the south. At its widest part it measures approximately 2000 feet. Where the roll is effective, the coal is only 4 feet thick.

As a rule the floor clay in the county is thin. At Divernon the upper 6 feet is a white clay which grades downward into a harder, greenish-blue shale. The clay slacks on exposure and heaves readily.

A layer of bowlders lies 5 feet below the floor. At the Black Diamond mine the clay averages 2½ feet in thickness. It slacks in the air and heaves readily when wet.

Other Coals

In the area underlain by coal No. 6 in Sangamon County very little drilling has been done to determine the position of and character of the lower coals. Through the kindness of Mr. A. J. Moorshead, General Manager, Madison Coal Corporation, the Survey has been able to examine the log of the company's shaft No. 6 at Divernon.

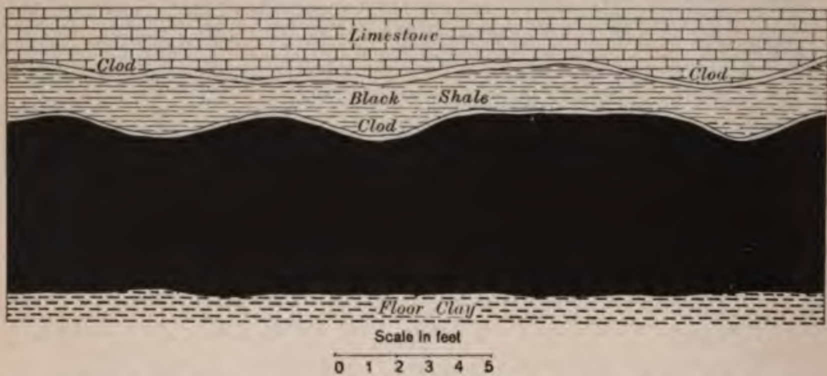

Fig. 47.—Irregular contact between limestone, shale, and coal, Black Diamond Coal Co., Auburn. (Face main south, east side.)

This shaft was sunk to a depth of 604 feet or 274 feet below the "blue-band" coal. In this distance 7 coals ranging in thickness from 1 foot to 4½ feet were penetrated. Coal No. 5, 46 feet below coal No. 6, is 2 feet 11 inches thick, half of its thickness in the vicinity of Springfield. A 2-foot 2-inch bed was found 61 feet below coal No. 5. At intervals of 30, 60, and 82 feet below the last bed mentioned are coals having the respective thicknesses of 13, 14, and 20 inches. A 4-foot 5-inch bed which probably represents the Murphysboro (No. 2) coal was penetrated 235 feet below coal No. 6.

The beds regarded as most favorable for future operations are coals No. 2 and No. 5. The former is doubtless developed over most of the county, and its thickness wherever it has been found in District VII is sufficient to strengthen the belief that it will be economically important at some future time.

In the northern part of Christian County coals No. 5 and No. 6 are of about the same thickness, and in many places it is almost impossible to distinguish one from the other in drill-hole logs. It is

believed that the same conditions will be found in Sangamon County when deeper drilling is carried on in Tps. 14 and 15 N., especially in the eastern side of the county. At this time it is impossible to outline the workable area of coal No. 5 with any degree of accuracy. In the townships mentioned, however, it is almost certain that coal No. 5 will be developed to a much greater degree than at persent.

The thin coals mentioned cannot be correlated at present. Locally one or another of them may be developed to workable thickness, but it is regarded doubtful that they will ever be extensively operated.

SUMMARY OF COAL RESOURCES

In the following summary of coal resources, attention has been confined to coal No. 6 because most of the information available relates to this bed. Furthermore, comparatively little is known regarding the lower coals in District VII, and estimates regarding them would necessarily be extremely unreliable.

In the calculations represented in the figures a tracing of the map, Plate I, was used. All of the information regarding the coal was placed by the side of the symbols representing drill holes and mines, and it was then possible to outline areas underlain by coal No. 6 and to determine its average thickness in a given area. Areal measurements were made with the planimeter, and computations were based on an average specific gravity of 1.3, or an average of 1770 tons of coal per foot per acre. Figures on coal production were taken from the reports of the Bureau of Labor Statistics and those of the Mining Board.

TABLE 18.—*Summary of coal resources (coal No. 6) in District VII.*

County	Area	Average thickness		Original tonnage	Amt. mined 1881-1913 incl.	Amount rendered unminable	Total amt. mined and rendered unminable	Amt. remaining in ground, end of 1913
	Sq. mi.	*Ft.*	*In.*		*Tons*	*Tons*	*Tons*	*Tons*
Bond	270	7	..	2,140,992,000				
	68.67	5	..	388,946,880				
	30.78	3	4	116,225,280				
				2,646,164,160	3,160,126	2,585,558	5,745,684	2,640,418,476
Christian	163	7	..	1,292,524,800				
	132	5	11	884,766,643				
	84	7	6	713,664,000				
	70	7	..	555,072,000				
	81	4	..	367,027,200				
				3,813,054,643	21,654,626	17,717,421	39,372,047	3,773,682,596
Clinton	34.83	3	..	118,366,272				
	101.61	6	10	786,504,172				
	96.57	4	..	437,577,984				
	265.14	7	..	2,102,454,144				
				3,326 536,300	16,032,809	13,117,752	29,150,561	3,297,385,739
Macoupin	430.92	7	..	3,417,023,232				
	434.97	4	..	1,970,936,064				
				5,387,959,296	73,459,119	60,102,915	133,562,034	5,254,397,262

TABLE 18. *Continued*

County	Area	Average thickness		Original tonnage	Amount mined 1881-1913 incl.	Amount rendered unminable	Total amt. mined and rendered unminable	Amt. remaining in ground, end of 1913
	Sq. mi.	*Ft.*	*In*		*Tons*	*Tons*	*Tons*	*Tons*
Madison	500	6	5	3,634,588,800	56,005,118	45,822,369	101,827,487	3,532,761,313
Fayette	176.4	6	6	1,298,868,480				
	564.75	4	..	2,558,995,200				
				3,857,863,680				3,857,863,680
Marion	450	4	..	2,039,040,000				
	139.5	6	.	948,153,600				
				2,987,193,600	20,228,469	16,550,565	36,779,034	2,950,414,566
Montgomery	113	8	..	1,024,051,200				
	322	7	6	2,735,712,000				
				3,759,763,200	16,902,790	13,829,555	30,732,345	3,729,030,855
Perry	599	6		4,071,283,200				
	95	8	..	860,928,000				
				4,932,211,200	26,918,284	22,024,050	48,942,334	4,883,268,866
Randolph	111.6	6		758,522,880	13,618,584	11,142,478	24,761,062	733,761,818
St. Clair	436	6	9	3,333,830,400	77,532,658	63,435,811	140,968,469	3,192,861,931

8-B-11

TABLE 18.—*Concluded*

County	Area	Average thickness		Original tonnage	Amount mined 1881-1913 incl.	Amount rendered unminable	Total amt. mined and rendered unminable	Amt. remaining in ground, end of 1913
	Sq. mi.	*Ft.*	*In.*		*Tons*	*Tons*	*Tons*	*Tons*
Washington	491	5	..	2,781,024,000	1,829,468	1,496,837	3,326,305	2,777,697,695
Sangamon	244	7	..	1,934,822,400				
	72	4	..	326,246,400				
				2,261,068,800	18,630,275	15,242,952	33,873,227	2,227,195,573
Shelby	311	6	6	2,289,955,200				
	90	5	..	509,760,000				
				2,799,715,200	1,133,796	927,651	2,061,447	2,797,653,753
Grand Total....	6,978.14			46,279,496,159	347,106,122	283,995,914	631,102,036	45,648,394 123

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PUBLICATIONS OF THE ILLINOIS COAL MINING INVESTIGATIONS

Bulletin 1. Preliminary Report on Organization and Method of Investigations, 1913.

Bulletin 2. Coal Mining Practice in District VIII (Danville), by S. O. Andros, 1914.

Bulletin 3. A Chemical Study of Illinois Coals, by Prof. S. W. Parr, 1914.

Bulletin 4. Coal Mining Practice in District VII (Mines in bed 6 in Bond, Clinton, Christian, Macoupin, Madison, Marion, Montgomery, Moultrie, Perry, Randolph, St. Clair, Sangamon, Shelby, and Washington counties), by S. O. Andros, 1914.

Bulletin 5. Coal Mining Practice in District I (Longwall), by S. O. Andros, 1914.

Bulletin 6. Coal Mining Practice in District V (Mines in bed 5 in Saline and Gallatin counties), by S. O. Andros, 1914.

Bulletin 7. Coal Mining Practice in District II (Mines in bed 2 in Jackson county), by S. O. Andros, 1914.

Bulletin 8. Coal Mining Practice in District VI (Mines in bed 6 in Franklin, Jackson, Perry, and Williamson counties), by S. O. Andros, 1914.

Bulletin 9. Coal Mining Practice in District III (Mines in beds 1 and 2 in Brown, Calhoun, Cass, Fulton, Greene, Hancock, Henry, Jersey, Knox, McDonough, Mercer, Morgan, Rock Island, Schuyler, Scott, and Warren counties), by S. O. Andros, 1915.

Bulletin 10. Coal Resources of District I (Longwall) by Gilbert H. Cady, 1915.

Bulletin 11. Coal Resources of District VII by Fred H. Kay, 1915.

Bulletin 83. United States Bureau of Mines, The Humidity of Mine Air, by R. Y. Williams, 1914. (Copies of this bulletin can be obtained by addressing the Director, Bureau of Mines, Washington, D. C.)

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Department of Mining Engineering, University of Illinois
U. S. Bureau of Mines

BULLETIN 12

Coal Mining Practice
IN
District IV

BY

S. O. ANDROS
(Field Work by S. O. Andros, C. M. Young, and J. J. Rutledge)

Published by
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The Forty-seventh General Assembly of the State of Illinois, with a view of conserving the lives of the mine workers and the mineral resources of the State, authorized an investigation of the coal resources and mining practices of Illinois by the Department of Mining Engineering of the University of Illinois and the State Geological Survey in co-operation with the United States Bureau of Mines. A co-operative agreement was approved by the Secretary of the Interior and by representatives of the State of Illinois.

The direction of this investigation is vested in the Director of the United States Bureau of Mines, the Director of the State Geological Survey, and the Head of the Department of Mining Engineering, University of Illinois, who jointly determine the methods to be employed in the conduct of the work and exercise general editorial supervision over the publication of the results, but each party to the agreement directs the work of its agents in carrying on the investigation thus mutually agreed on.

The reports of the investigation are issued in the form of bulletins, either by the State Geological Survey, the Department of Mining Engineering, University of Illinois, or the United States Bureau of Mines. For copies of the bulletins issued by the State and for information about the work, address Coal Mining Investigations, University of Illinois, Urbana, Ill. For bulletins issued by the United States Bureau of Mines, address Director, United States Bureau of Mines, Washington, D. C.

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Urbana
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1915

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FIG. 1. Map showing area (shaded) of District IV.

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COAL MINING PRACTICE IN DISTRICT IV

By S. O. ANDROS

Field work by S. O. Andros, C. M. Young, and J. J. Rutledge

INTRODUCTION

District IV of the Illinois Coal Mining Investigations as shown in fig. 1, includes all mines in seam 5 of the Illinois Geological Survey correlation operating in Cass, DeWitt, Fulton, Knox, Logan, Macon, Mason, McLean, Menard, Peoria, Sangamon, Schuyler, Tazewell, and Woodford Counties.

A detailed description of the districts into which the State has been divided and the method of collecting the data upon which this report is based are contained in Bulletin 1, "A Preliminary Report on Organization and Method of Investigations."

Comparative statistics have been compiled for the year ended June 30, 1912, although later information is available, because statistics for the seven districts previously reported on have been compiled for that year.

The discovery of coal in District IV was made early. Up to the present time the first mention of coal in the country which afterwards became the United States has been erroneously credited to Father Louis Hennepin, who shows on a map published in 1689 the location of a "cole mine" along the Illinois River. The credit for this first mention of coal does not, however, belong to Hennepin for the first discovery of coal in the

d State by Europeans was made by Joliet and Marquette in 1673. Margry's account[1] of Joliet's voyage says, e said M. Joliet adds, That he had set down in his Journal exact Description of the Iron-Mines they discovered, as o of the Quarries of Marble, and Cole-Pits, and Places re y find Salt-Petre, with several other things." Joliet's 1674[2] (See fig. 2) shows the location of "Charbon de near the present city of Utica. La Salle in his ntenac (1680) referring to the Illinois River[3] says, e have seen no mines there though several Pieces of Copper e found in the Sand when the River is low. There is the best mp in that Country I have seen anywhere, though it grows turally without culture. The Savages tell us, that they have ound near this Village some yellow Metal; but that cannot be old, according to their own Relation, for the Oar of Gold annot be too fine and bright as they told us. There are Coal-Pits on that River." Marquette's Journal was first published in France by Thévenot in 1681.[4] Accompanying the narrative was a map (See fig. 3) copied by Thévenot from one made by Marquette. Both original and copy show the same location of "Charbon de terre" as does Joliet's map.

Father Louis Hennepin, a Récollect priest, accompanied La Salle's expedition to the Illinois country in 1680 as chaplain and in his "A New Discovery of a Large Country in America," published in English in 1689, says with reference to the country along the Illinois River from its source to the site of the present city of Peoria:[5] "There are Mines of Coal, Slate, and Iron; and several pieces of fine red copper, which I have found now and then upon the Surface of the Earth, makes me believe that there are Mines of it; and doubtless of other Metals and Minerals, which may be discovered one time or another. They have Already found Allom in the country of the Iroquoise." Hennepin's map accompanying this narrative[5] locates

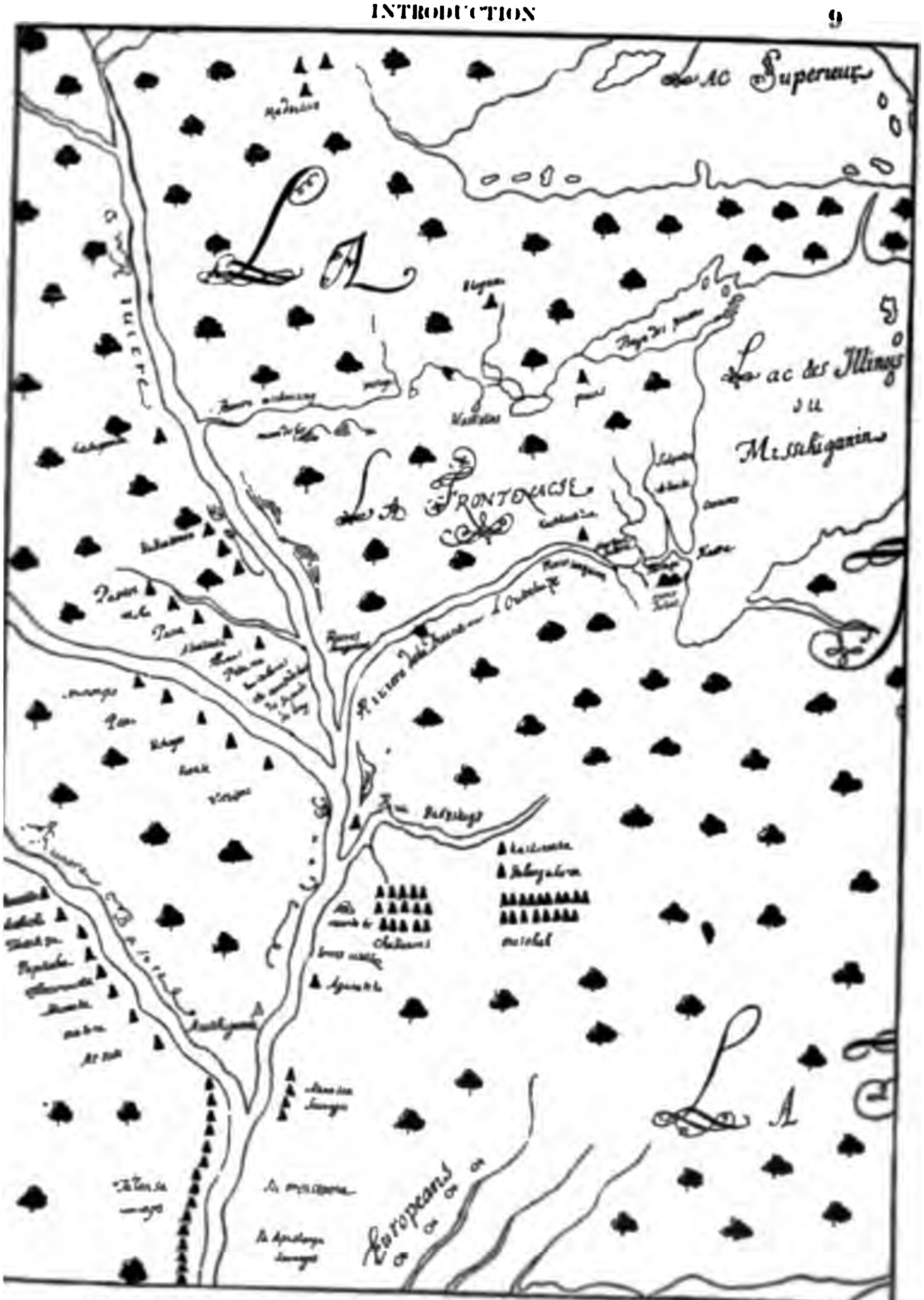
[1]Découvertes et Établissements des Francais, I, p. 261. Published at Paris, 1681.

[2]Thwaites, Jesuit Relations, Vol. 19, p. 86.

[3]Margry, Vol. I, p. 465.

[4]Recueil de Voyages.

[5]Thwaites, Hennepin's New Discovery, Vol. I, p. 152.



THE CENTRAL PORTION OF JOLIET'S MAP, 1674, SHOWING THE MISSISSIPPI AS THE "BAUDE."

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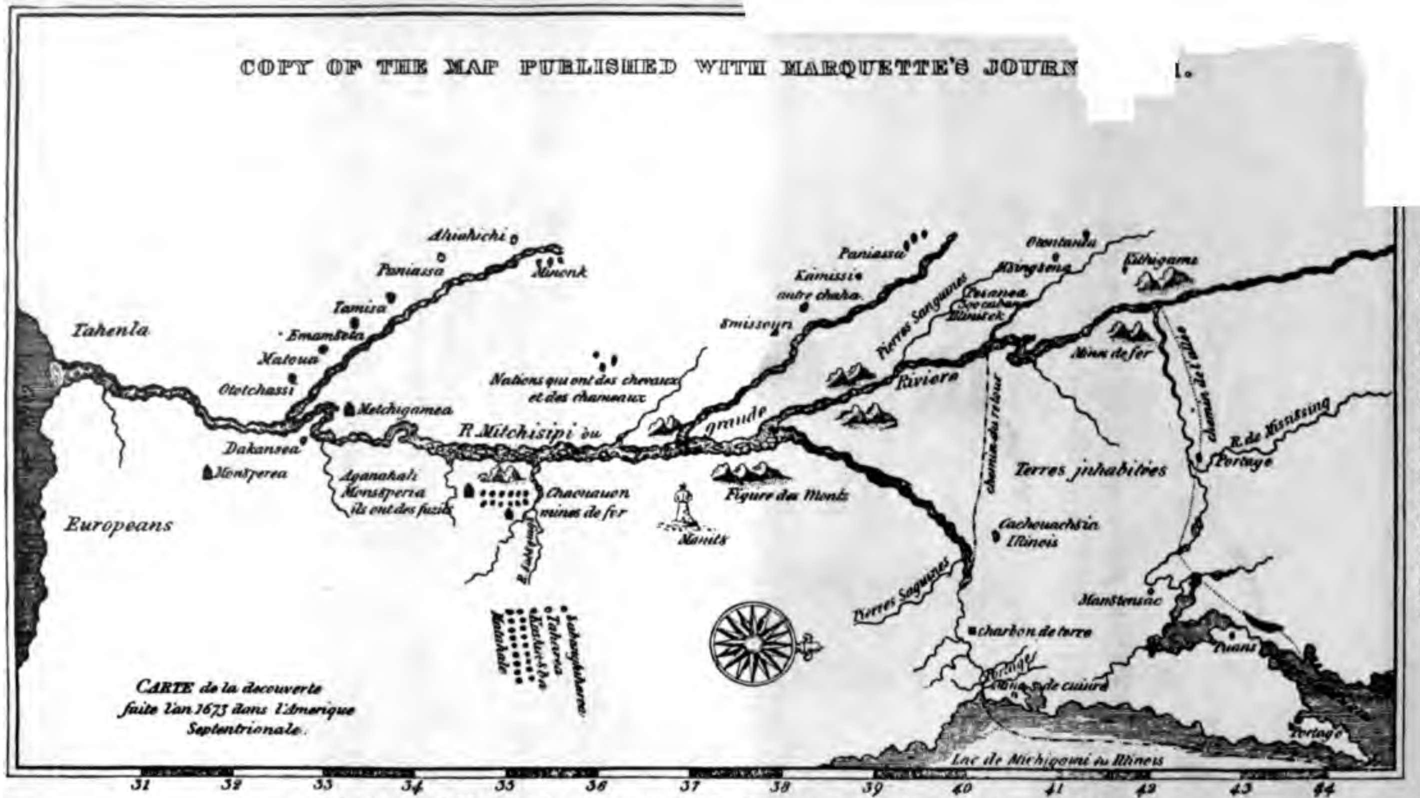


FIG. 3. Copy of Marquette's map published by Thévenot, 1681 (From "A History of the Mississippi Valley," by Spears and Clark).

a "cole mine" on the Illinois River above Fort Crevecœur (Peoria) copied from Joliet's map or Marquette's.

Other early mention of coal in District IV is made by Patrick Kennedy in his journal of an expedition undertaken in the year 1773 from Kaskaskias Village in the Illinois country in search of a copper mine. Under the date of August 6, 1773, he writes[1], "At sun-set we passed a river called Michilimackinac (Mackinaw River in Tazewell County). Finding some pieces of coal, I was induced to walk up the river a few miles, though not far enough to reach a coal mine. In many places I also found clinkers, which inclined me to think that a coal mine, not far distant, was on fire, and I have since heard there was."

In 1823[2] Peoria was called "a small settlement in Pike county on the west bank of the Illinois river, about 200 miles above its junction with the Mississippi." Beck says, "This section of country is not very rich in minerals. Coal, however, is abundant on the banks of Kickapoo creek, about one mile above its mouth. It was first discovered by the soldiers stationed at the fort (Clark), and being of a good quality, was used by them for fuel. It is found 12 or 14 feet below the surface; is overlaid by slate, limestone and sandstone; and contains vegetable remains."

By 1837 the existence of workable coal was known in three newly created counties in the district. In McLean County it was stated[3] "Of the minerals, limestone and coal abound in several settlements." A description of Peoria County published in the Peoria Register and North-western Gazette[4] contains the following statement: "The stone-coal is said to be little inferior to that of Pittsburg, and is found in the bluffs of all the creeks and Illinois River. It is generally used for fuel at Peoria in winter; is hauled from one to three miles, and is worth 12 cents per bushel." In Schuyler County[3],

[1] Hicks, Thomas Hutchins. A Topographical Description, p. 127.

[2] Beck. Gazetteer of Illinois and Missouri.

[3] Illinois in 1837 & 8: With A Map.

[4] April 8, 1837.

TABLE 1.—*General data by counties for District IV for the year ended June 30, 1912.*[a]

County	No. mines		Production in short tons	Tons mined by machine	Average days of active operation	Total no. employees	No. surface employees	No. kegs of powder used in blasting coal	Haulage No. mines using				Accidents to employees	
	Shipping	Local							Motor	Cable	Mule	Hand	Killed	Injured
Cass	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DeWitt	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fulton	19	76	2,381,605	395,533	148	3,719	302	117,473	6	3	23	63	6	4
Knox	0	19	21,456	0	155	71	13	443	0	0	1	18	0	0
Logan	4	0	429,555	0	185	677	83	20,899	1	1	2	0	1	0
Macon	4	0	211,219	0	138	521	39	2,219	0	0	4	0	2	6
Mason	0	0	0	0	0	0	0	0	0	0	0	0	0	0
McLean	2	0	96,898	0	226	200	20	1,000	0	1	1	0	0	0
Menard	4	8	220,418	0	180	376	43	9,721	0	0	11	1	2	0
Peoria	14	50	1,207,723	117,101	164	1,652	176	68,535	9	4	39	12	1	5
Sangamon	23	5	3,712,869	0	159	5,217	385	181,047	12	0	12	4	3	16
Schuyler	0	4	2,736	0	129	10	1	156	0	0	0	4	0	0
Tazewell	5	3	239,424	126,206	175	392	47	7,689	0	1	7	0	0	4
Woodford	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	75	165	8,523,903	638,840	157[b]	12,835	1,109	400,182	28	10	100	102	15	35

[a]Compiled from Thirty-first Annual Coal Report of Illinois.
[b]Averaged by mines; not by counties.

"Mount Sterling was a thriving village of about 50 houses. Coal of a good quality was found within one mile of the town."

By 1870 the output of the district amounted to about 250,000 tons and in 1880 it had increased to over one million. In the year ended June 30, 1912, the production of the district was 8,523,903 tons, 14.8 per cent of the production of the State. This output came from 240 mines, 75 shipping and 165 local, employing 12,835 men and operating on an average 157 days during the twelve months.

Only 7.5 per cent of the production is mined by machines and the district is characterized by wasteful and dangerous shooting off the solid with excessive charges of black powder. The average number of tons gained per 25-pound keg of powder is 20.8. Although the production of coal is only 14.8 per cent of the production of the State, there is used in District IV 31.2 per cent of all the black powder used in Illinois.

The proportion of accidents caused by pit cars is remarkably high, 33.3 per cent of the fatal and 45.7 per cent of the non-fatal accidents occurring from this cause. The accident record of the district is the best of any important district in the State. Table 1 gives general data for the district and Table 2 comparative statistics for District IV and for the State.

Thanks are due to the operators of the district who willingly allowed examination of their mines and to the superintendents and mine managers who accompanied the engineers through the mines.

Especially generous assistance was rendered by Mr. F. S. Peabody, President, Peabody Coal Company; Mr. F. J. Devlin, Superintendent, The Jones and Adams Coal Company; Mr. Horace Clark, President, Clark Coal and Coke Company; Mr. M. S. Coleman, Superintendent, Big Creek Coal Company; and the officials of the Woodside Coal Company. Professor C. W. Alvord of the University of Illinois gave valuable aid in determining the site of the first discovery of coal.

BLE 2.—Co parative statistics for District IV and the State for the year ended June 30, 1912[a]

	District (All mines)	State (All mines)	Per cent of district
	8,523,903	57,514,240	14.8
	638,840	25,550,019	2.5
age daily tonnage	54,292	359,464	
of powder used in blasting coal	409,182	1,313,448	31.2
erage no. days of active operation	157	160	
tal no. employees	12,835	79,411	16.1
. days work performed	2,015,095	12,705,760	15.8
. surface employees	1,109	7,049	15.7
. underground employees	11,726	72,362	16.2
erage no. face workers (miners, loaders, and machine men)[b]	9,265	53,318	17.4
No. underground employees per each surface employee	10.6	10.3	
No. tons mined per day per employee	4.2	4.5	
No. tons mined per day per surface employee	48.9	50.9	
No. tons mined per day per underground employee	4.7	4.9	
No. tons mined per day per face worker[b]	5.9	6.7	
No. fatal accidents	15	180	8.3
Per cent from falling rock or coal	33.3	54.4	
Per cent from pit cars	33.3	18.8	
Per cent from use of explosives	6.7	7.2	
Per cent from gas explosions	......	......	
Per cent from undercutting machines	......	......	
No. fatal accidents per 1000 employees	1.2	2.3	
No. tons mined to each life lost	568,260	319,524	
No. non-fatal accidents	35	800	4.4
Per cent from falling rock or coal	34.3	45.5	
Per cent from pit cars	45.7	26.3	
Per cent from use of explosives	5.7	2.6	
Per cent from gas explosions	5.7	2.9	
Per cent from undercutting machines	2.9	2.8	
No. non-fatal accidents per 1000 employees	2.8	10.1	
No. tons mined to each man injured	243,540	71,893	

[a]Compiled from Thirty-first Annual Coal Report of Illinois.
[b]Shipping mines only.

DESCRIPTION OF COAL SEAM

The topography of the surface in District IV is flat in some areas, and rolling, with hills as high as 300 feet in others. No. 5 coal outcrops on the surface in Peoria, Fulton, and Knox Counties but lies at depths of 300 to 600 feet in Macon County, 400 feet in McLean and 260 to 300 feet in Logan.

The average thickness of the coal is 4 feet, 8 inches as reported in the thirty-first Annual Coal Report of Illinois from 240 mines. The seam has a uniform appearance from top to bottom and the coal is hard and massive. It shows fine laminations with knife-edge mother coal partings. In some places there are discontinuous bands of pyrites near the middle of the seam. The seam lacks the blue-band characteristic of No. 6[1]. Table 3 gives the analysis of the coal in No. 5 seam.

TABLE 3.—*Analyses of No. 5 coal in District IV*

Average thickness of coal	No. samples	Proximate analysis of coal: 1st, "as rec'd," with total moisture. 2nd, "Dry," or moisture free				Sulphur	B. t. u.	Unit coal B. t. u.
		Moisture	Volatile matter	Fixed carbon	Ash			
4 ft., 8 in.	54	15.10	36.79	37.59	10.52	3.52	10514	———
		Dry	43.33	44.28	12.40	4.15	12384	14447

Udden states that, "in the mines near East Peoria and at Edwards the coal runs out against the drift in several of the entries. Miners recognize that these defects in the coal are due to erosion and they speak of the drift as 'wash.' The drift generally consists of sand or silt, which in some places has been found to contain embedded trunks of trees and other vegetation. Experience has shown that the surface of the bedrock does not always conform to the present topography of

[1]Illinois Geological Survey, Bull. 14, Coal Resources of Illinois, DeWolf.

the land and operators are careful to avoid unprofitable explorations of places where 'wash' has been encountered."[1]

The immediate roof is a black sheety shale locally called slate. This shale varies in thickness from a few inches to 35 feet and in places contains "niggerheads" of iron pyrites. In many mines between the coal and the shale there is in places

FIG. 4. Typical clay vein

a layer of iron pyrites two or three inches thick. Where this layer is present the shale is protected from the air and stays up; where it is not present the shale falls badly and in places caves to a height of 35 feet.

[1]U. S. G. S. Bull. 506, Geology and Mineral Resources of the Peoria Quadrangle, Illinois, Udden.

The cap rock in most mines is limestone but in a few is a fine-grained micaceous sandstone. In some places the shale of the immediate roof is absent and the cap rock comes in contact with the coal. "When the limestone is disseminated and mingled with the shale the roof is soft and weathers quickly owing perhaps to the presence of marcasite.[1] It is then called clod and the niggerheads are iron carbonate.

FIG. 5. Displacement due to horizontal movement (Photo by J. A. Udden)

From the viewpoint of the miner the chief characteristic of the district is the great number of clay veins extending through the coal and roof shale crossing their bedding planes. Fig. 4 shows a typical clay vein. These clay veins are fissures which have been filled with a hard light-gray clay. Besides clay veins the physical features which affect mining are small

[1]Udden, op. cit.

ts, sli[illegible] and rolls. In one mine where the shale of the nediate roof is absent the sandstone has cut out the coal for feet along an entry. Fig. 5 shows the result of horizontal ement near Peoria. "A wedge of sandstone has divided the f shale part of which continues under the sandstone and [illegible]e.[1] In the figure "a" is dark shale with some streaks [illegible] ewhat shattered; "b" is the roof shale; "c" is the [illegible] "d" is sandstone.

[illegible]n this district in many places sticks to the roof is separat[illegible] with [illegible]ulty. In one mine about an h of coal is left up to protect the roof shale from the moist- of the air.

The floor in most places is a dark-gray fireclay which aves badly when wet. At one mine the floor is a blue fireclay ntaining nodular concretions of iron pyrites.

[1]Udden, op. cit.

MINING PRACTICE

Seam 5 in this district dips at the rate of about five feet to the mile towards the southeast. It outcrops in Peoria, Fulton, and Knox Counties and in the face of the bluffs of the Illinois River. The cover is thickest in Macon County where the coal lies at a depth of 600 feet. There is one stripping on a surface outcrop and there are 96 mines at which the coal is reached by drifts. At the remaining 143 mines shafts or slopes are sunk to the seam. The mines examined vary in depth from 60 to 570 feet but all except two were less than 300 feet deep.

In the closed workings 235 mines are worked on the room-and-pillar system. Four mines are operated on the longwall system.

Mining methods in most of the room-and-pillar mines are crude and dimensions of workings are not suited to physical conditions. The mines are comparable to those in the Danville District[1] where the many rolls in the roof cause deviations from projected systems. The workings are irregular and in some small mines are but little better than "gophering." The district is characterized by many horsebacks where the roof, either sandstone or limestone, cuts out the coal. The original method of mining in the district is to run the parallel main entries from the shaft toward the boundaries, and from the main-entries to turn cross-entries at intervals of 350 to 400 feet. Rooms are turned off these cross-entries on 30 to 42-foot centers and are run 20 to 30 feet wide. Room-pillars are gouged as the miner pleases and average 9 feet in width. This haphazard method is productive of so many squeezes that in some mines a modification of the system has been made in which stub or room entries are turned off the cross-entries. This method approaches the panel system and is called locally "block

[1]Andros, S. O., Coal Mining Practice in District VIII (Danville), Illinois Coal Mining Investigations, Bulletin 2, 1914.

TABLE 4.—*Dimensions of workings in feet.*

Mine no.	Depth of shaft	System of mining	Past life in years	Entry width			Entry pillar width			Barrier pillar width		Room		Width of room pillar	Room neck		Distance from entry to full room width	Distance between room centers	Width of room stump	Width of crosscuts	No. rooms on room entry	Has mine had squeezes?	Per c[illegible] seam
				Main	Cross	Room	Main	Cross	Room	Main	Cross	Width	Length		Width	Length							
25	185	Semi-panel	22	8	8	8	36	30	24	50	24	24	180	6	8	7	18	30	22	8	23	Yes	54
26	Slope	Room-and-pillar	25	8	8	....	30	21	....	50	....	26	190	6	8	8	30	32	24	8	....	No	56
27	170	Semi-panel	12	12	12	12	20	15	12	50	50	30	200	8	8	9	20	38	30	8	30	No	53
28	150	Semi-panel	12	8	8	8	25	20	8	40	20	24	180	10	8	10	15	34	26	8	18	Yes	54
29	185	Room-and-pillar	5	8	8	....	36	24	....	40	....	24	180	8	8	7	18	32	24	8	....	No	57
31	Slope	Room-and-pillar	10	8	10	....	15	12	....	25	....	22	210	10	8	7	18	32	24	13	....	No	63
32	Slope	Semi-panel	6	8	8	8	30	30	24	20	20	20	150	12	8	10	15	32	24	8	30	No	57
33	285	Semi-panel	12	8	8	8	20	20	20	50	40	30	150	6	8	10	35	36	28	6	15	No	64
34	200	Room-and-pillar	21	8	10	....	30	34	....	38	....	28	180	10	10	9	30	38	28	4	....	Yes	42
35	187	Semi-panel	12	8	8	8	35	35	30	60	50	26	200	9	8	9	27	35	27	8	14	Yes	56
36	238	Semi-panel	19	12	12	12	30	24	10	30	20	25	240	10	8	9	27	35	27	12	24	Yes	48
37	235	Semi-panel	7	12	12	12	35	30	30	60	40	30	240	12	12	15	15	42	30	12	28	Yes	50
38	245	Semi-panel	25	10	10	10	27	24	20	35	35	30	200	6	10	9	20	36	26	10	25	No	62
39	204	Semi-panel	8	12	12	12	30	30	20	50	40	24	250	12	12	11	18	36	24	10	25	Yes	65
40	270	Semi-panel	20	10	10	10	30	24	20	35	35	24	200	6	8	9	18	30	22	7	27	Yes	50
41	365	Room-and-pillar	31	16	16	....	20	30	....	80	....	25	200	10	12	9	15	35	23	8	....	No	56
42	570	Longwall	10	10	10	....	....	....	....	....	....	9	....	....	....	....	....	42	....	....	....	......	96

[a]Figures supplied by operators.

room-and-pillar." (See fig. 6.) In a few mines a sufficient cross-barrier pillar is left to confine a squeeze to the block in which it originates but in most mines the barrier pillar is gouged and squeezes ride over it extending unchecked until they reach a horseback or some ungouged pillar which is large enough to stop them. In several mines squeezes originating in rooms have traveled to the main barrier pillar and to the solid coal at the entry face. In one mine an entry was saved from a threatened squeeze by very heavy timbering ahead of the squeeze.

Eleven of the 16 mines examined are at present operated on this semi-panel system but the relative dimensions of room and room-pillar have not been changed from previous operation. The average room is 26 feet wide and the average room-pillar 9 feet. These dimensions are unsafe under the roof found in the district. Room width is not uniform but rooms are narrowed to avoid horsebacks and widened again where the coal resumes its normal thickness. There is a temptation to get all the coal possible on the advance working because the numerous rolls make uncertain the total tonnage which can be extracted from any area, and the rolls interfere seriously with any projected plan because they are expensive to cut through. When a roll is encountered in turning a room off an entry work on this room is stopped and a "wing-room" is turned off the adjacent room. (See fig. 7). The wing-room carries the side of the roll as a rib and follows its course until the room reaches the position it would have occupied if it had cut through the roll. It is then continued on its proper course.

Cleat is not sufficiently developed to be a factor in the direction of driving rooms.

Cross-cuts are sometimes driven at irregular distances to avoid cutting through the rolls.

Room-necks vary in width from 8 to 12 feet and are generally widened on both sides to reach full room width but the angle of widening varies. The distance from the entry to the point where full room-width is reached varies from 15 to 35 feet. Room track is almost always in the center of the rooms

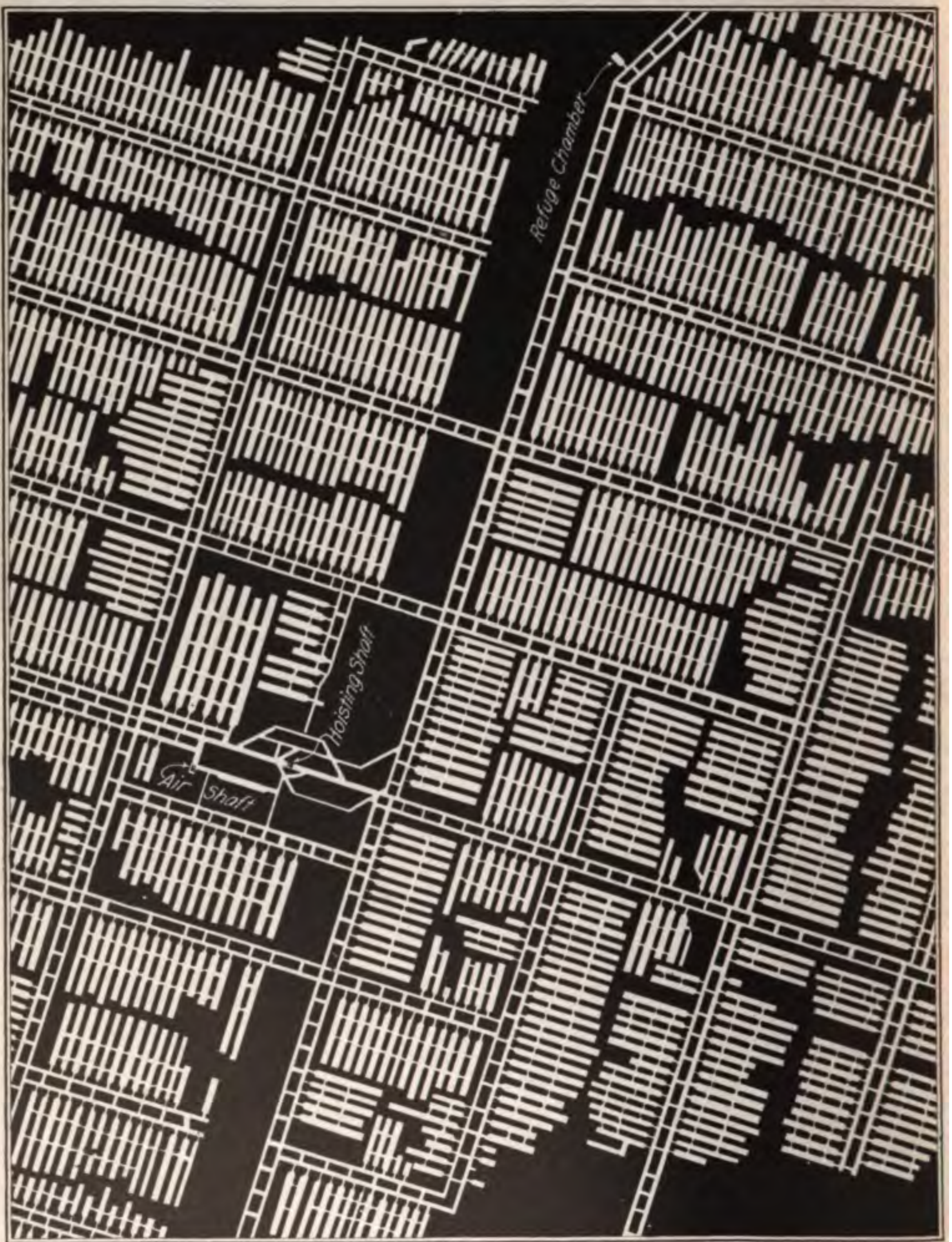


Fig. 6. Typical block room-and-pillar mine

and the gob is thrown on each side of the track. Table 4 gives dimensions of workings at the mines examined.

Pillars are drawn in only a few mines and in those drawing is not done systematically but is confined to shooting slabs off the pillars where they are thickest. In nearly all mines room-

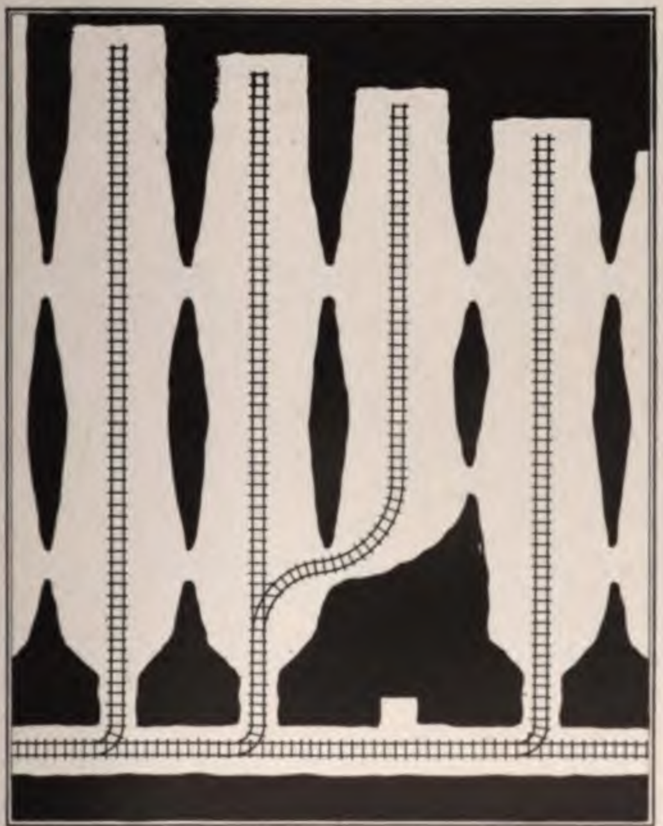


FIG. 7. Wing-room turned to avoid roll

pillars are tapered to cross-cuts as shown in fig. 7. In one mine an attempt was made to draw pillars and track was laid along the rib but objections were raised by the miners to this position of the track and the attempt was abandoned.

The floor is a fireclay which heaves badly even when dry.

n l cause of the heaving floor is insufficient pillar-
w

of the mines examined is now worked on the longwall rst although it was opened on the room-and-pillar system. is ine is worked by the 45-degree advancing system and n od of working does not differ from that employed in I.[1] Room centers at the longwall face are 42 feet e face between centers is called a "place." Two each place. The clay under the coal is undercut vith a feet and is wedged down as needed to fill cars. The miners at each place are required to brush two feet of roof along the roadway and to build packwalls to protect the roadway. Where the amount of rock obtained from the miners' brushing is not sufficient for completing the packwall, "company men" make a further brushing on the permanent haulage ways and bring to the face the rock thus obtained. Two men can average 10½ tons of coal daily. The coal at this mine averages 4½ feet in thickness and the amount of rock hoisted is less than in mines in District I. When producing 750 tons of coal per day there are only 18 to 20 tons of rock which can not be used underground in the gob. In District I about one-third as much rock as coal is hoisted. There is considerable difficulty in cleaning up after a suspension of working. After a shut-down of three months it takes two weeks to clean the mine during which period about 125 tons of rock per day are hoisted. Fig. 8 shows the rock dump at this mine.

Although the mines are shallow operators have very little trouble with seepage water and at no mine is more than 30,000 gallons of water pumped in 24 hours. Several mines are muddy but the water drains off easily into the sumps at the shafts or is pumped to them by electric gathering pumps from small sumps inby. The shallowest mines are the muddiest and the water seeps through the roof or comes in where breaks to the surface occur. One or two gasoline pumps are used at the main sumps but in general the main pump is operated by steam and the gathering pumps by electricity. The source of the

[1]Andros, S. O., Coal Mining Practice in District I (Longwall). Bulletin 5, Illinois Coal Mining Investigations, 1914.

water can be told by its character. Where the water is acid it has been derived principally from seepage and its acidity is caused by the solution of iron sulphate; where it is neutral chemically it is surface water which has seeped through the shaft directly into the sump. At one mine it is sufficiently pure to be given to the mules which are stabled underground.

FIG. 8. Rock dump at longwall mine

The labor in the district is of various nationalities. Americans perhaps predominate but there are many Italians, Germans, Hungarians, Poles, Lithuanians, and Croatians. Table 5 gives the per capita production of coal for the mines examined, the district, and the State. The small percentage of its production which is undercut accounts for its low per capita tonnage as compared with the remainder of Illinois. Face workers average only 5.8 tons per day in District IV as compared with 7.4 tons for all other districts combined. The per

TABLE 5.—*Per capita p*

Mine no.	Employees: Surface	Employees: Underground	Employees: Face-workers (miners, loaders, and machine men)*	Employees: Total	Average daily tonnage	Underground employees per each surface employee	Tons per day per surface employee	Tons [illegible] und[illegible]	Tons per day per face-worker (miners, loaders, machine men)*	Tons per day per employee
25	15	275	199	285	1200	18.3	80.0	4.4	6.0	4.2
26	22	220	190	242	900	10.0	40.8	4.1	4.7	3.7
27	10	155	110	165	550	15.5	55.0	3.5	5.0	3.3
28	16	290	200	306	950	18.1	59.3	3.3	4.8	3.1
29	17	250	160	267	1100	14.7	64.7	4.3	6.9	4.1
31	30	380	266	410	1200	12.7	40.0	3.2	4.5	3.0
32	14	170	160	184	550	12.3	39.3	3.2	3.4	3.0
33	25	320	247	345	1600	12.8	64.0	5.0	6.5	4.6
34	12	125	85	137	650	10.4	54.2	5.2	7.6	4.7
35	7	65	47	72	275	9.3	39.3	4.2	5.8	3.8
36	25	400	311	425	2450	16.0	98.0	6.1	7.9	5.8
37	35	472	370	507	2700	13.5	77.1	5.7	7.3	5.3
38	17	320	260	337	1400	18.8	82.3	4.4	5.4	4.2
39	21	370	295	391	2400	17.6	114.1	6.5	8.2	6.1
40	13	160	115	173	700	12.3	53.8	4.4	6.1	4.0
41	10	52	44	62	325	5.2	32.5	6.3	7.4	5.3
42	15	200	179	215	750	13.3	50.0	3.8	4.2	3.5
Total District IV	1,109	11,726	9,265	12,835	54,292	10.6	49.0	4.7	5.8	4.2
All other districts combined	5,940	60,636	44,053	66,576	305,192	10.2	51.4	5.0	7.4	4.6

*Shipping mines only.

capita production of coal for employees of longwall mines is greater than in District I, the ratio for face workers being 4.2 to 2.8. This higher average daily production is due to the greater thickness of the seam in longwall mines in District IV, inasmuch as the same amount of labor at the face is required to gain a slice of coal three feet thick as to gain one four and one-half feet thick.

TABLE 6.—*Tonnage per fatal and non-fatal accident*

District	I	II	III	IV	V	VI	VII	VIII
No. tons per non-fatal accident	25,675	62,513	85,363	243,540	63,872	95,472	78,788	57,194
No. tons per fatal accident	419,362	No fatalities	128,045	568,260	148,275	316,564	362,172	187,469

The accident record of this district is by far the best of any district in Illinois. Its mines produce more than twice as much coal per non-fatal accident as the mines of any other district and over one-third more tons per fatal accident, except

FIG. 9. Photograph of underground refuge chamber

those mines in District II. The total annual production of District II is only 500,102 tons; its mines are small and employ comparatively few men. A comparison of the tonnage per fatal and non-fatal accident for each district in Illinois is given in Table 6. The percentage of accidents from pit cars in this

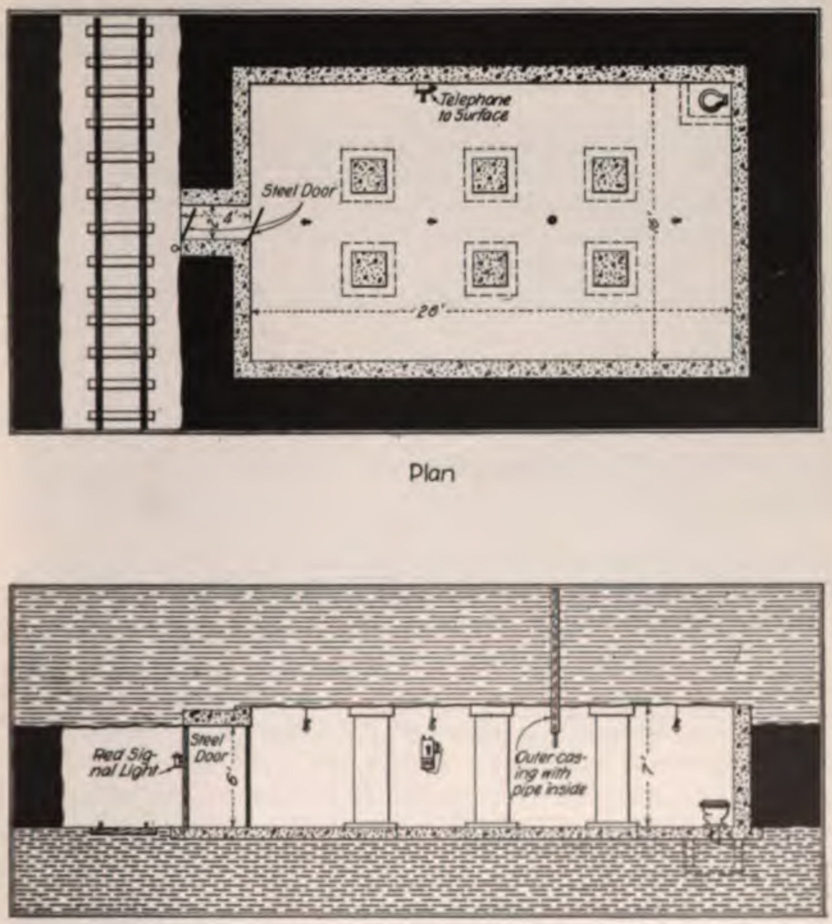
·istric very high. Nearly one-fourth of the total fatal and
on accidents can be prevented by better discipline along
ie ;e roads and by cleaning up the gob lying close to the
ae no district in the State can a material decrease in
accomplished so easily. The roof is comparatively
I : percentage of accidents from falls of roof and
Table 7 gives causes of accidents in the district.

LE 7.—*Causes of accidents to employees*

	Percentage	
	District IV	All other districts combined
Causes of fatal accidents		
Fall of rock or coal	33.3	56.3
Pit cars	33.3	17.6
Use of explosives	6.7	7.3
Gas explosions	0.0	0.0
Undercutting machines	0.0	0.0
Causes of non-fatal accidents		
Fall of rock or coal	34.3	46.0
Pit cars	45.7	25.4
Use of explosives	5.7	2.5
Gas explosions	5.7	2.7
Undercutting machines	2.9	2.7

The Peabody Coal Company in its Peabody mine at Sherman has prepared an underground refuge chamber, so that if the miners are imprisoned through any cause they may have a safe place of retreat where communication with the surface can be maintained. This refuge chamber, shown in fig. 9 in perspective and in fig. 10 in plan and vertical elevation, is lined with concrete and closed by an air lock protected with steel explosion-proof doors. A hole 8 inches in diameter is drilled from the surface into the chamber which is 7 feet high, 28 feet long, and 16 feet wide where the shale roof is supported by six concrete pillars two feet square. An empty powder can placed in the mouth of the drill hole shows its position in fig. 9. Through the drill hole fresh air can be pumped to the chamber and

supplies can be lowered. Refuge chambers in coal mines are an admirable precaution and at least two should be built in every mine, one on each side, particularly in mines in southern Illinois in which explosive gas and dust are found.



Plan

Longitudinal Section through Center

FIG. 10. Sketch of underground refuge chamber

Where there have been so many squeezes under comparatively shallow cover surface subsidence is to be expected. Surface cracks and subsidence seem to be related to the absence

of limestone cap rock. Where sandstone is the cap rock subsidence is more marked. Several cases of damage to buildings d of broken foundations have been reported and in some stances after a squeeze sink-holes, 9 to 10 feet deep, have ared in fields.

rcentage of extraction of coal from the seam in r mines in the district is low varying from 50 aging 54.

VENTILATION

The coal of this district generates very little explosive gas l therefore it is not necessary to supply extraordinary quans of air to the working face for the purpose of gas dilution. In only a few of the mines examined is gas found in sufficient uantity to make a cap in a testing lamp. Gas is found in ome mines in roof caves and it occurs casually in small quanities in abandoned areas. An occasional accident occurs from gnition of small bodies of gas in these areas. The quantity of air supplied to the working face is generally adequate for proper ventilation.

TABLE 8.—*Pressures developed by dust of face samples in explosibility apparatus*

District	No. samples	Pressure in pounds per square inch at 2192 degrees F.
I	11	8.400
II	5	5.880
III	5	7.805
IV	17	7.700
V	7	7.105
VI	16	5.950
VII	24	7.175
VIII	6	8.925

The coal dust on the ribs and roof of rooms near the face is explosible as shown in Table 8. Coal dust on the ribs of entries is intimately mixed with finely ground shale and fireclay and is kept moist in many mines by seepage of surface

water. At some mines the rib dust along all entries is wet. The admixture of shale dust and water with the coal dust accounts for the comparative freedom from explosions which the district has enjoyed. The moisture extracted from the dust by the air current is continuously replaced by seepage. The humidity of the mine air is normal. Hygrometers were installed by the Illinois Coal Mining Investigations in the intake and return of the three following mines: Empire No. 2 mine,

FIG. 11. Stopping built of Pyrobar block

Clark Coal and Coke Company, Peoria; Peerless mine, Jones and Adams Coal Company, Springfield; Woodside mine, Woodside Coal Company, Springfield. Readings three times daily were made at each mine during the working year. The average temperature of the outside air during the months these mines operated was 40 degrees F. The average temperature of the return air was 63 degrees F. The relative humidity of the outside air was 70 per cent and of the return air in the mines 94 per cent. Details of this study of humidity of air in Illinois mines can be found in Bulletin 83, U. S. Bureau of Mines, The Humidity of Mine Air, by R. Y. Williams.

The average size of air shafts at the mines examined is 7 by 10 feet. The average width of fan is 4 feet and the average

diameter 13 feet. At one mine in which insufficient air was being given by the fan a booster fan was installed underground near the end of the main entry. The present intake of this mine is 26,200 cubic feet per minute. It is reported by the operators that before the installation of the booster fan the intake was 10,800 cubic feet.

At most mines the fans are always run as blowers but in a few they exhaust in summer and blow in winter. At two

FIG. 12. Pyrobar block showing core holes

mines the intake air is heated; at one by passing it over a coil of one-inch pipe 695 feet long through which live steam is passed at a pressure of 80 pounds per square inch; at the other by jets of steam exhausted into the air shaft from the fan engine. At these mines it is stated that in the coldest weather the intake air at the bottom of the air-shaft has a temperature above freezing. Clean-up expense in this district can be lessened materially by heating the intake air and every mine in the district could profitably install a steam coil or drum. The initial expense would be small and the expense of operation slight compared with the saving in clean-up cost. The shale roof spalls off badly in spring and summer in many mines and in some continues to fall till the limestone or sandstone cap

rock is exposed. In several mines in new entries driven during winter the roof begins to fall with the advent of summer and caves to the cap rock. The cause of the falling is chiefly the expansion of the black shale with the rise in temperature of the intake air current. Maintaining the air current at a more nearly constant temperature by means of preheating with steam coils would decrease the roof falls by decreasing the seasonal range of temperature.

TABLE 9.—*Data relative to ventilation*

Mine no.	Air shaft			Fan*		
	Depth in feet	Size in clear in feet	No. of compartments	Type	Diameter in feet	Width in feet
25	185	8 by 8	2	Paddle-wheel	15	3½
26	196	8 by 15	2	Sturtevant	6¾	4
27	170	6 by 14	1	Paddle-wheel	12	4
28	150	5 by 10	2	Paddle-wheel	20	7
29	185	8 by 16	2	Paddle-wheel	16	4
31	60	9 by 15	1	Duncan	22	6
32	68	6 by 9	2	Paddle wheel	10	4
33	285	6 by 12	2	Robinson	12	6
34	200	5 by 10	2	Paddle-wheel	12	4
35	162	6 by 8	2	Paddle-wheel	12	6
36	200	7½ by 15	....	Stevens	12	4
37	235	10 by 14	3	Buffalo Forge	16	5
38	245	6 by 12	2	Jeffrey	10	4
39	204	10 by 12	2	Cappell	13½	7½
40	270	....	2	Jeffrey	6	3½
41	365	4½ by 7	1	Stevens	10	2
42	570	6 by 8	2	Duncan	15	3½

*Paddle-wheel refers to straight blade type of fan often home made.

Gob stoppings are built in most mines and in many they are leaky allowing a large percentage of the air blown by the fan through the intake to short-circuit into the return before reaching the faces of the rooms. At one mine a tight gob stopping is provided and a considerable amount of gob removed from the road by filling the entire cross-cut through the 20-foot pillar. At two of the mines examined tight stoppings are

built of Pyrobar blocks as shown in fig. 9. Pyrobar is a gypsum block made in two sizes: 12 by 30 by 4 inches and 12 by 30 by 5 inches. For decreasing weight three longitudinal core holes are made in the blocks as shown in fig. 12. The block 4 inches thick has a compressive strength of 154 pounds per square inch and the block 5 inches thick a strength of 162 pounds. The greater compressive strength of the block five inches thick is due to greater thickness of its walls. The four-

FIG. 13. Fire-seal repaired by Pyrobar

inch block weighs 12 pounds per square foot of surface and the five-inch block, 13½ pounds. The price of the four-inch block is four cents per square foot, f. o. b. Fort Dodge, Iowa. The Pyrobar block is well adapted to mine stoppings and fire seals in dry mines where it is not subjected to heavy roof settlement. The blocks can be sawed into desired sizes with a hand saw. The mortar used in building stoppings with this material has a gypsum base and costs $6.50 per ton. Two men can build three 6 by 12-foot stoppings in eight hours. In this district a 6 by 12-foot stopping in place costs $6.50; about nine cents per square foot of surface. Fire seals can be built

easily and quickly with these blocks which are fire resistant. Fig. 13 shows a broken fire seal repaired with Pyrobar.

Many mines in the district are troubled with small fires which originate from two causes: the use of excessive charges of black powder at the face in blasting coal and the mixture of fine coal and iron pyrites in gob in damp rooms and entries. Almost all of the fires are quenched with water before they attain serious proportions but some of them require sealing off.

FIG. 14. Concrete overcast

The usual seal is built of concrete and costs from 50 to 100 dollars in place. In some mines an unnecessarily expensive mixture of concrete is used. In a few mines seals are built of brick and gob.

Table 9 gives ventilating equipment. The shafts of the mines examined were all sunk before the passage of the law requiring fire-proofed linings and each one of the air-shafts is timber-lined.

For carrying the intake air over the return airway overcasts are built at all but one mine at which an undercast has been excavated and the intake air carried under the return airway. Overcasts are constructed of timber only, timber and

crete, old rails or steel I-beams and concrete, concrete only, k and timber, brick and steel, and Pyrobar. Fig. 14 shows oncrete overcast at a point where the haulage way underlies ailroad track on the surface. To prevent possible subsid- of the surface and consequent damage to the railroad k the approaches to the overcast are made 5 feet thick and oor of the overcast is reinforced with 4-inch steel I-beams.

ines at which there were water gages, previous passage of the State law requiring water gages at all es, the readings varied from 1 to 3¼ inches. At one mine fan is driven by an electric motor; at all of the others mined the fan is steam driven.

BLASTING

In District IV only 7.5 per cent of the annual production mined by machines. The remaining 92.5 per cent, 7,885,063 ns, is gained by shooting off the solid. In no other important district in Illinois mining on the room-and-pillar system is so small a percentage of the production undercut. Dangerous and wasteful excess of black powder is used in blasting coal. At one mine where two men were killed by a blown-out shot a drill hole was measured eleven feet in length and three inches in diameter. At many mines the number of tons of coal gained per keg of powder has decreased from 25 to 19 since the introduction of shot-firers. The miners drill longer holes and put in heavier charges when they do not fire their own shots and consequently are not exposed to the danger resulting from blown-out shots. The excess of powder above that necessary to bring down the coal shatters the coal producing an unnecessary amount of slack, cracks the roof increasing the danger of accident from roof-fall, and causes fires at the face.

Black powder is used in every room-and-pillar mine in the district. At one mine size CC only is used; at six, C only; at two, C and CC; at four, F only; at two, FF only; and at one F, C, and CC. In the longwall mines 40 per cent dynamite is used in roof brushing. In a few places where the coal in longwall mines is tight size CC black powder is used for blast-

TABLE 10.—*Blasting data.*

Mine no.	Kind of undercutting machine	Size of powder	Pounds of powder per ton of coal	Tons of coal per keg of powder	Powder cost in cents per ton of coal	Length of holes in feet	Diameter of holes in inches	Holes per shot firer	Per cent of coal over 1¼ inches[b]
25	Solid shooting	F, C and C C	1.47	17	10.20	6	2¼	112	68
26	Solid shooting	C	1.30	18	9.73	6	2½	150	70
27	Chain	F	0.45	50	3.15	6	2½	No shot firers	70
28	Solid shooting	F	1.30	18	9.73	6	2¼	300	75
29	Solid shooting	F	1.56	16	10.92	7	2	250	71
31	Chain	F F	0.63	40	4.41	6	2½	125	67
32	Solid shooting	F F	1.19	21	8.33	6	2½	90	68
33	Solid shooting	C	1.30	18	9.73	5	2½	100	75
34	Solid shooting	C and C C	1.32	19	9.24	6	1½	70	67
35	Solid shooting	C and C C	1.19	21	8.33	7	2½	50	....
36	Solid shooting	C	1.04	24	7.28	6	2¼	125	67
37	Solid shooting	C	1.32	19	9.24	6	1½	100	65
38	Solid shooting	C	0.81	31	5.67	6	2½	80	....
39	Solid shooting	F	1.25	20	8.75	6	1¾	100	70
40	Solid shooting	C	1.19	21	8.33	6	2¼	100	71
41	Solid shooting	C C	1.30	18	9.73	7	2½	65-70	70
42	Longwall	....	......	....	......	....	......	......	[a]

[a] 68 per cent over 2 by 2½ inch holes.
[b] Figures supplied by operators.

ing coal. The amount used for this purpose is very small. Black powder is purchased in metal kegs throughout the district.

Shots were formerly fired by squibs in the mines examined but as numerous accidents occurred through miners or shot-firers returning too soon to the face to discover the cause of missed shots fuse was substituted.

At many mines powder is carelessly handled during trans-

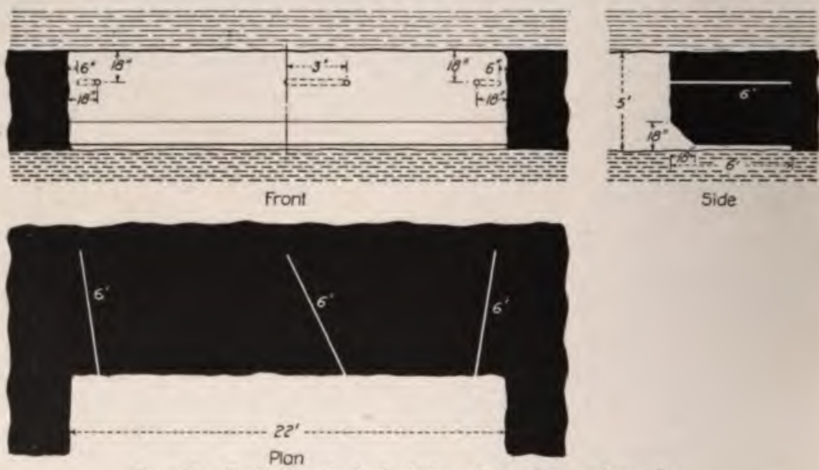


FIG. 15. Typical method of placing shots after undercutting

portation to the face and is carried from the surface to the underground partings exposed in open cars.

As in every district in Illinois, metal powder kegs are often opened with pick points, dummies are frequently filled with "bug dust," and miners many times fill their cartridges while wearing lamps on their caps.

Stricter discipline in regard to common-sense observance of safety regulations is greatly needed in the district and will reduce both the number of accidents and the proportion of slack coal.

In the mines where shooting off the solid is practiced shooting in rooms is done off the weak rib. A round usually consists of four holes, two rib and two center shots. At one mine an irregularly shaped piece of coal was seen 17 feet in

circumference and 6 feet high which had been blasted off a rib with an 8-foot shot.

In those mines in which the coal is undercut the usual method of placing drill holes is shown in fig. 15. Seam 5 has always been considered hard by the miners and in undercutting machines only chisel bits are used. At every mine examined in which the coal is undercut electric undercutting machines are used. Chain breast machines are most popular but "pneumelectric" are used in a few mines in the district.

FIG. 16. Entry sixteen feet wide without timber

In many mines the coal sticks to the roof and to the floor. In one mine where shooting is done off the solid about an inch of coal is left on the roof. At another an inch or so of fireclay sticks to the bottom of the seam and causes some difficulty in maintaining proper cleanliness of the coal arriving at the tipple. Table 10 gives blasting data. The figures for percentage of lump coal were supplied by the operators. The average tonnage per keg of powder for the district is 20.8.

TIMBERING

The black sheety shale roof of the district falls and caves badly when exposed to the air. In many mines in places the thin layer of iron pyrites called "sulphur" between the coal and the shale protects the shale which stays up in entries without propping. Fig. 16 shows an entry 16 feet wide where the roof stays up without any timbering. In some mines this layer

of pyrites may be present in one section and absent in others and it may be present in one of two adjacent mines and absent in the other. For this reason the timbering costs of mines in this district are variable. The amount of timbering necessary also depends upon the number of clay veins in the coal. In the vicinity of these veins the roof is difficult to support and usually requires heavy timbering. The total cost of timber in the room-and-pillar mines including room props ranges from

FIG. 17. Three-piece entry set

1½ to 4 cents per ton of coal hoisted and the total timbering expense including cost of timber and labor of setting in place varies from 12 to 20 cents per ton. The average cost of timber supply is estimated at 3 cents per ton of coal and the average cost of timber in place at 14 cents.

Where entry timbering is necessary the three-piece entry set of round timber is much used as shown in fig. 17. Legs are usually battered to resist side pressure. In some mines one end of the crossbar is placed in a hitch in the rib and in others where narrow entries must be driven both ends are hitched in the rib as shown in fig. 18. Centers vary from 2 to 8 feet.

The percentage of white-oak in purchased timber varies from 10 to 70 and averages 60. The life of timber is generally two to three years although in some mines timber stands for

ten years without decay. In a few mines where timber loss by decay has been heavy the timbers are given a preservative treatment before installation. At one mine where creosote is used as a preservative timber is treated with one gallon per cubic foot. Untreated round white-oak timbers with a small-end diameter of 10 inches cost 10 cents per running foot. The treated timber at the pit-mouth costs 17 cents per running foot.

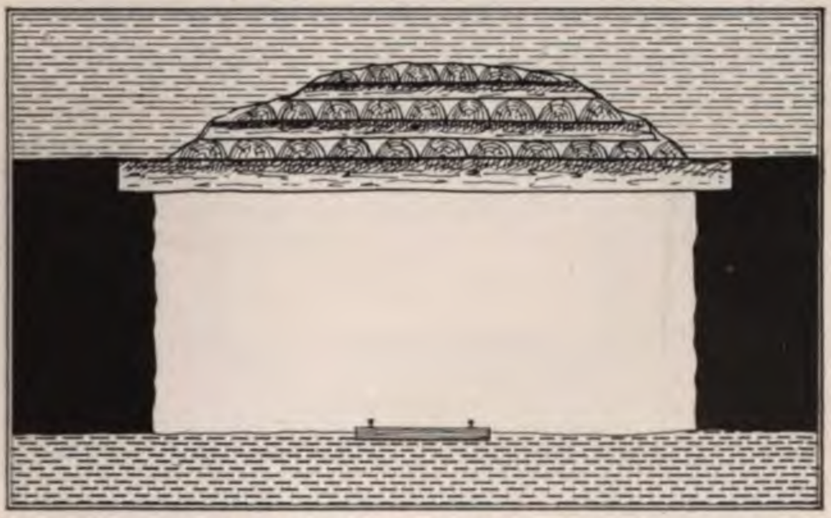


FIG. 18. Cross-bar set in hitches in ribs

At one mine if a crossbar breaks it is replaced by one which has been treated with carbolineum. In another all new shaft sets are being treated with it.

Steel I-beams are used in many mines for collars of entry sets. Comparative average sizes of white-oak round timbers and steel I-beams in District IV for various spans are as follows:

Span in feet	Diameter of round white-oak timbers in inches	Size and weight of steel I-beams
8	6	18 pound; 8-inch
10	7	18 pound; 8-inch
12	9	18 pound; 8-inch
14	10	40 pound; 12-inch
16	12	40 pound; 12-inch
18	14	52 pound; 12-inch

At one mine where white-oak crossbars after failure are being replaced by second-hand steel I-beams, a 30-pound 12-inch I-beam 16 feet long costs \$4.80 at the pit-mouth and a 12-inch white-oak timber of the same length costs \$3.00. The cost of setting in place is reported to be about the same for steel and timber. An average estimate for the district is 3 cents per pound for I-beams in place including cost of steel and labor in setting. If there is much rock work to do in set-

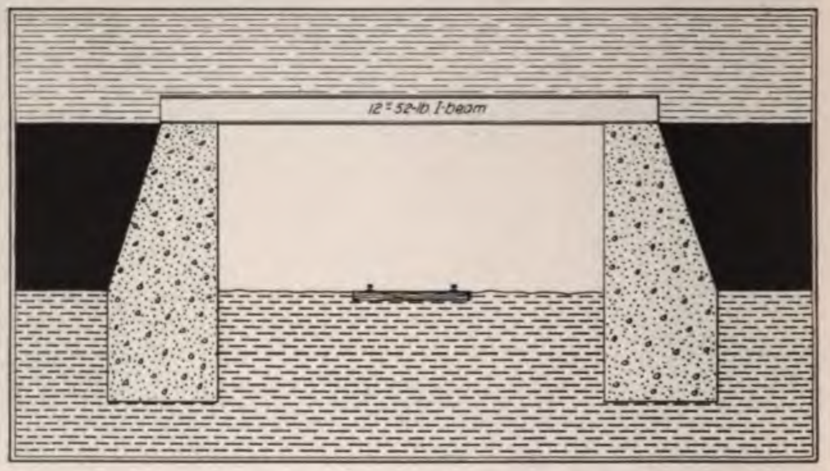


FIG. 19. Steel I-beams and concrete at bottom

ting the crossbar the cost is increased. In one mine where placing the sets requires considerable rock work an entry-set composed of a 10-inch 35-pound steel I-beam 16 feet long on 8-inch white-oak legs 8 feet long costs approximately \$20.00 in place.

At one mine on one side of the shaft the bottom for 200 feet is concreted as shown in fig. 19 and 52-pound 12-inch I-beams on 2-foot centers support the roof. The concrete walls are imbedded four deep in the floor.

At several mines old railroad and streetcar rails are used as crossbars. In one mine at the partings the sets are composed of old railroad ties as legs and 17-foot rails as crossbars. The rails were purchased for \$12.00 per ton. Old rails purchased for this purpose vary in weight from 55 to 65 pounds

per yard. They are not as good as structural-steel I-beams for support of heavy roofs because their carbon content is high and their section is not the best for this purpose. Therefore, they break more easily than do I-beams. It is not unusual to find that they have deteriorated in use, and have little value as roof supports.

The roof in rooms in this district is supported by unpeeled split and round props with a diameter of 4½ inches at the small end. Crossbars are seldom used in rooms. For ordinary use the length of props varies from 4½ to 6 feet. Longer props are used in some mines where clay veins are cut through or where caving roof is encountered. For lengths up to five feet the average cost of room-props is one cent a running foot. With increasing length the cost advances rapidly. The prices paid at several mines are:

Length in feet	Cost in cents per prop
4½	4½
5	5
5½	6½
6	10
6½	13
7	17
8	25
9	30

The cost of room props per ton of coal ranges from ½-cent to 3½ cents. The number of tons of coal produced for each room prop purchased ranges from 2 to 12, varying in different mines and in different sections of the same mine.

Table 11 gives data on props in rooms. The figures for the number of props per 100 square feet of roof were obtained by counting the props in a measured length in each of several typical rooms of measured width. The average number of props per 100 square feet of roof is 3.3 for the mines examined. Table 12 compares the number of props used in rooms for each district.

T E 11.—*Data concerning props in rooms*

no.	100 of roof	Cost in cents per 100 square feet of roof	Average length in feet	Round or split	Cost in cents per ton of coal[a]
	7	16.7	4½	Both	......
	4	25.2	4⅔	Both	3.00
	7	17.2	4⅔	Both	1.75
28	.....	......	5	Both	3.00
29	.....	......	4¾	Both	2.90
31	6.5	30.0	5¼	Both	2.00
32	4.0	20.0	5	Both	2.70
33	2.8	16.8	5	Both	2.50
34	.....	......	6	Split	......
35	.....	......	6	Both	......
36	2.6	26.0	6	Both	......
37	2.8	18.2	6	Both	2.40
38	1.6	8.8	5½	Split	......
39	1.1	10.0	6	Split	0.50
40	2.4	14.4	5⅔	Round	1.00
41	.....	......	5½	Split	2.00
42	.....	......	4½	Both	......

[a]Figures supplied by operators.

TABLE 12.—*Comparison for each district of number of props used in rooms*

District	Average no. props in rooms per 100 sq. ft. of roof
I	Longwall
II	6.0
III	Few props except at clay veins
IV	3.3
V	3.2
VI	2.9
VII	3.7
VIII	5.5

Generally throughout the district props are not kept close enough to the face. More face bosses are needed to keep the props near enough to the face to prevent accidents from roof fall.

All shafts at the mines examined have timber linings.

HAULAGE

Seam 5 is flat lying in this district and few heavy grades are encountered in mine entries. An occasional two per cent grade is found persisting for a few hundred feet. Entries are not very narrow and physical conditions generally are favorable to comparatively rapid and economical haulage. Yet efficient haulage is found in few mines. In only 28 of the 240 mines of the district are locomotives used. Rope haulage is

FIG. 20. First gasoline mine-locomotive in Illinois (Photo loaned by Mr. Frank R. Fisher)

used in 10 mines. In 100 mines underground haulage is done by mules and in 102 the cars are pushed to the bottom by hand. At 7 of the mines examined cars are hauled by mules from the face to the bottom. At 8 mines electric locomotives are in use and at two, gasoline locomotives.

The first gasoline locomotive used in Illinois mines was built by the Sangamon Coal Company and put in its mine at

1904. This crude machine, fig. 20, pulled in a
to ine mine cars each weighing loaded 4,000 pounds.
in the mine at that time weighed 16 pounds per yard.
l but one of those mines in which mechanical haulage
in led ack conditions are fairly good. The speed of
s averages about 10 miles per hour. At one mine
rrent is used for driving a 7-ton locomotive.

BLE 13.—*Ton mileage of locomotives*

ine no.	Kind of locomotive	Weight of locomotive in tons	Miles traveled per shift by locomotive	Ton mileage per shift		
				In coal	In cars	Total
25	Electric	10	....	......	......	....
26	Electric	11½	39.77	736	620	1356
27	None	....	....	......	......	....
28	Electric	10	37.87	710	426	1136
29	Gasoline	8	13.25	167	103	270
31	Electric	12	34.09	690	665	1355
32	None	....	....	......	......	....
33	Electric	7½	20.00	590	190	780
34	None	....	....	......	......	......
35	None	....	....	......	......	......
36	Electric	12	31.06	852	582	1434
37	Electric	15	30.00	990	726	1716
38	Electric	10	38.63	946	676	1622
39	Gasoline	12	33.14	829	563	1392
40	None	....	....	......	......	......
41	None	....	....	......	......	......
42	None	....	....	......	......	......

An illustration of the false economy of neglecting road bed is shown by the comparison of ton-mileage obtained by gasoline locomotives in two mines (See Table 13). At one of these proper attention is paid to the road-bed and a daily ton-mileage of 1392 is achieved by a 12-ton locomotive. The locomotive travels 33.14 miles per shift and burns 27 gallons of gasoline using 2 gallons of engine oil. Engine oil costs 34 cents per gallon at the mine. At the other mine road-bed and track are neglected and in poor condition and only 270 ton-

miles are made during eight hours; the eight-ton locomotive travelling 13.25 miles per shift.

TABLE 14.—*Amount of air required for ventilation with various sizes of gasoline locomotives.*

Engine cylinder size, in.	No. cylinders	Speed, rev. per min.	Piston displacement[a] (Cu. ft. per min.)	Maximum probable amount of noxious gases (Cu. ft. per min. at 60° F. and 30 in. barometer) produced with: Good carburation, CO	Good carburation, CO_2	Bad carburation, CO	Bad carburation, CO_2	Amount of air (Cu. ft. per min.) required to dilute exhaust gases to 1 part CO per 1000 parts of air[b]: Good carburation	Bad carburation
4.75 by 5.25	4	800	172	2.61	6.80	9.91	3.65	2,610	9,910
5 by 5	4	600	136	2.06	5.37	7.84	2.88	2,060	7,840
5 by 5	4	800	182	2.76	7.18	10.48	3.86	2,760	10,480
5 by 6	4	800	218	3.30	8.60	12.56	4.62	3,300	12,560
5.5 by 5	4	600	165	2.50	6.51	9.50	3.50	2,500	9,500
6 by 6	4	700	275	4.17	10.86	15.85	5.82	4,170	15,850
6 by 7	4	500	220	3.47	9.04	13.10	4.85	3,470	13,190
6.5 by 7	4	500	260	4.07	10.63	15.50	5.70	4,070	15,500
6.5 by 8	4	650	300	6.04	15.76	23.00	8.46	6,040	23,000
7 by 7	4	500	312	4.73	12.33	17.07	6.62	4,730	17,970
7 by 7	6	500	468	7.08	18.49	26.07	9.92	7,080	26,970
8 by 7	4	500	407	6.16	16.08	23.45	8.62	6,160	23,450
8 by 7	6	500	610	9.24	24.10	35.14	12.93	9,240	35,140

[a] Area piston in square feet multiplied by stroke in feet multiplied by number of cylinders multiplied by revolutions per minute.

[b] Maximum amount of carbon monoxide which can be breathed for short and infrequent intervals without injurious effects.

The limitations of the gasoline locomotive for use in mines are clearly shown by Prof. O. P. Hood, Chief Mechanical Engineer of the U. S. Bureau of Mines.[1] Prof. Hood says, "The size of a gasoline locomotive that may with safety be introduced into a mine depends upon the amount of air that can be mixed with the exhaust gases in the most unfavorable portion of the run of the locomotive. For each cubic foot of carbon

[1] Gasoline Locomotives in Relation to the Health of the Miners. Bulletin of the American Institute of Mining Engineers, October, 1914, p. 2607.

monoxide possible to generate in the engine there should be available 2,000 cu. ft. of air to mix with the exhaust gases if this air is for continued breathing, while for short and infrequent intervals the proportion may rise to one part in one thousand." Table 14 gives the data compiled by Prof. Hood.

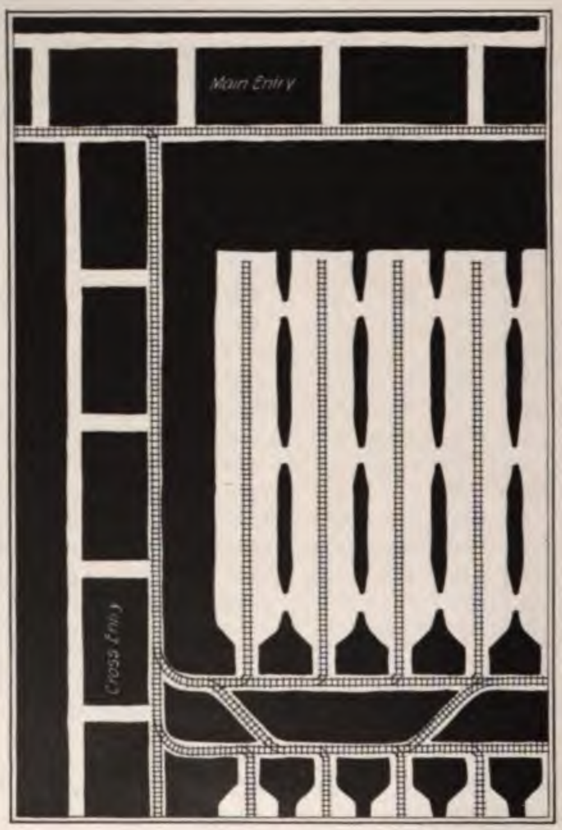


FIG. 21. Parting at mouth of room-entry

In no other district in Illinois is such a large percentage of fatal and non-fatal accidents caused by pit cars. Undoubtedly one reason for this high percentage is the gob alongside the tracks. Trip riders and drivers stumble on the pieces of shale or coal lying close to the rails and fall between the cars.

A comparison of the percentages of accidents caused by pit cars in Illinois districts is as follows:

District	Fatal	Non-fatal
I	16.6	21.9
II	No fatalities	25.0
III	25.0	0.0
IV	33.3	45.7
V	10.7	18.5
VI	23.7	27.8
VII	24.2	29.5
VIII	5.5	27.1

Table 15 gives haulage data.

The average weight of an empty pit car is 1329 pounds; of its load 3458 pounds; of car and load 4787 pounds. The percentage of total weight of car and load which is car weight is about 28. This is the relation which obtains between weight of modern steel railroad cars and total weight of car and load. The pressed-steel railroad cars with a capacity of 100,000 pounds weigh empty from 38,000 to 46,000 pounds.

Track gage varies from 24 to 42 inches, averaging 36, and rail weight on the main entries ranges from 16 pounds per yard to 45, averaging 28. In rooms in some mines wooden rails are used.

Gathering from rooms is entirely done by animals in the mines examined. Mules are used in all but one mine in which gathering is done by ponies. Mules are generally stabled underground and are kept in good condition. Their ton-mileage is not determined and very little is known about the work performed by them.

In mines working on the semi-panel system partings are made on the room-entries near the cross-entry as shown in fig. 21. No trolley is carried into the room-entry and the locomotive does not leave the cross-entry in picking up its load. At one mine empties coming from the cage are lifted to grade by an automatic steam car lift.

TABLE 15.—*Data relative to underground haulage*

Mine no.	Kind of haulage		Locomotive weight in tons and number of each weight[b]	Track gage in inches	Rail weight in pounds yard		Weight cars in	Capacity cars in	Percent total w which weig
	Main	Secondary			Main haulage	Secon-dary haulage			
25	Electric	Mules and ponies	One 10; three 6; one 3	36	30	12	1200	2600	31.6
26	Electric	Mules	One 12; one 7; one 6	42	40	16	1500	3700	29.6
27	Mules	Mules	....	36	16	16	1400	2800	33.3
28	Electric	Mules	Two 10	36	30	16	900	3000	23.1
29	Gasoline	Mules	One 8	36	30	16	1300	4200	23.6
31	Electric	Mules	Two 12; one 6	36	45	20	1300	3700	26.0
32	[a]	Mules	....	36	45	Wood in roo s	1000	2400	29.4
33	Electric	Mules	Two 7½; two 5	42	35	16	1900	4000	32.2
34	Mules	Mules	....	36	16	12	1400	3000	31.8
35	Mules	Mules	....	36	16	Wood in rooms	900	2300	28.1
36	Electric	Mules	Two 12	36	30	16	1500	4400	25.4
37	Electric	Mules	One 15; two 13	42	35	16	2200	6000	26.8
38	Electric	Mules	One 10; two 8	36	35	Wood in rooms	1000	2800	26.3
39	Gasoline	Mules	Three 12	42	30	20	1700	5000	25.4
40	Mules	Mules	....	35	16	Wood in rooms	1500	3500	30.0
41	Mules	Mules	....	24	20	12	740	2300	24.3
42	Mules	Mules	....	38	16	16	1165	3000	29.0

[a]Gasoline locomotive to be purchased. Rope haulage for 1500 ft. from slope
[b]Weight in tons expressed in figures

Ties are usually of white-oak and on the main haulage where locomotives are used have the dimensions 6 by 8 inches by 5 feet and on the secondary haulage 4 by 6 inches by 5 feet. At a few mines old props are used as ties.

The construction of underground stables complies with the State law. The stable at one mine is lined with brick and old boiler plates are used for ceiling. The provision of the State Mining Law to the effect that no light with an unprotected flame shall be taken into an underground stable is frequently violated but no oftener than in other districts. This provision should be strictly enforced throughout the State.

HOISTING

In District IV at 106 mines cars are hoisted from the bottom by steam; by horses at 43; and by hand at 90. The moderate daily production of the mines of this district and the comparatively short hoists require neither elaborate appliances nor great speed of hoisting. The hoisting equipment is adequate for their needs. The average daily production of the mines examined is about 1200 tons and the longest hoist 570 feet. As the mines with hoists longer than 300 feet have a production of less than 800 tons daily all of the coal mined can be raised to the surface by slow hoisting. Because speed of hoisting is not essential there is no automatic caging at the mines examined. The size of the average hoisting shaft is $7\frac{1}{2}$ by $15\frac{1}{2}$ feet.

At slope mines hoisting is often done by a partly balanced rope on a two-track incline where the weight of the descending empties assists in hoisting the loads.

At slope mines second-motion engines are used but at all except one of the shafts a first-motion engine hoists the cage. The cylinder size varies from 12 by 15 inches to 24 by 36, averaging 18 by 32.

The self-dumping cage is used at 11 of the mines examined but at most of the mines in the district the operators have purchased the platform cage.

Weighing is done at the tipple throughout the district.

Table 16 gives hoisting data.

TABLE 16.—*Hoisting data.*

Mine no.	daily ...uction	...elf-dumping cage	Hoisting shaft: ...epth in feet	Hoisting shaft: Size in feet	Engine: First motion	Engine: Cylinder size in inches	Drum: Diameter in feet	Drum: Length in feet
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] by 16	Yes	18 by 36	5	6
[illegible]	[illegible]	[illegible]	[illegible]	-------	-----	-------	----	----
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] by 18	Yes	18 by 36	6	7
28	950	[illegible]	150	8 by 16	No	14 by 20	6	8
29	1100	Yes	185	8½ by 15½	Yes	18 by 36	6	6
31	1200	Slope	90	7 by 8	No	-------	----	----
32	550	Slope	68	6 by 12	No	12 by 15	----	----
33	1600	Yes	285	8½ by 16	Yes	24 by 40	8	3⅙
34	650	Yes	200	7 by 14	Yes	16 by 32	6	7¾
35	275	No	187	8 by 16	No	12 by 15	5½	4½
36	2450	Yes	238	9⅓ by 19	Yes	24 by 36	8	6
37	2700	Yes	235	10 by 16	Yes	24 by 36	7	5
38	1400	Yes	245	7 by 14	Yes	20 by 36	6	2
39	2400	Yes	204	10 by 20	Yes	22 by 36	7	3
40	700	Yes	270	8 by 16	Yes	18 by 36	6	2
41	325	No	365	6 by 16	Yes	16 by 24	6	8
42	750	No	570	8 by 16	Yes	20 by 36	8	7

PREPARATION OF COAL

This district was among the first in Illinois to attempt to remove the separable impurities from coal and to separate sizes. Several large cities are located in the district and the local trade for domestic purposes has always been and still is a prominent factor. Fig. 22 shows a tipple designed for handling the local trade and shipping. Those mines located in or near cities naturally separate the coal into more sizes than the others and for this purpose several of them have installed re-screening plants. A typical separation at a mine catering to local domestic or "wagon" trade is:

Name	Size in inches
6 inch lump	Over 6
3 inch lump	Over 3
1¼ inch railroad lump	Over 1¼
6 inch egg	Over 3; through 6
Nut	Over 2; through 3
Pea	Over ¾; through 1¼
Screenings	Through ¾

At those mines which do not have a local trade the sizes commonly made are:

Name	Size in inches
Lump	Over 6
Egg	Over 3; through 6
Nut	Over 1¼; through 3
Screenings (Steam)	Through 1¼

Many mines ship run-of-mine coal and the percentage of the total production thus shipped varies from 1½ to 30.

The location of some mines near cities having diversified manufactures and various kinds of domestic furnaces leads to particular demands. At one mine 30 per cent of the output is

crushed to 2-inch size for use in distilleries. At another, 8-inch lump and egg are in demand. Several mines make a nut through $1\frac{1}{4}$ inches and over 1 inch and one makes a "domestic lump" over 3 inches.

In the total output of this district about 80 per cent of the coal is larger than $\frac{3}{4}$-inch, 75 per cent larger than 1 inch, 70 per cent larger than $1\frac{1}{4}$ inches, 48 per cent larger than 3 inches, and 25 per cent larger than 6 inches.

FIG. 22. Tipple designed for local trade and shipping

The impurities, shale, fireclay, and nodules of pyrites, are separated as far as possible at the face. Where fireclay is shot up with the coal the separation underground is comparatively easy on account of the contrast in color. A further picking is made at many mines on the screen and car; six pickers being employed at some mines.

Screens are of various types. They are built with one, two, and three decks and have a throw of 8 to 12 inches, making 75 to 80 shakes per minute. At one mine the screen is split into two compartments longitudinally, each division being five feet wide.

Table 17 gives data on coal preparation.

Power is usually obtained by burning slack under steam boilers. The largest installation at any mine examined is 750 H. P., the moderate outputs requiring only moderate horsepower. The efficiency of these power plants is low. From 3.2 to 4.3 per cent of the output is burned under boilers at the

surface plant. Good combustion under boilers is obtained at one mine by the use of steam blowers and the slack burns with no clinkers. Wasted coal ranges from 0.5 to 0.7 per cent.

There is no power plant at one mine. Electric power is purchased at 2½ cents per kilowatt-hour. Three-phase 60 cycle alternating current is brought to the plant at 4000 volts and there transformed to 275 volts. The installation consists of three 15 H. P. motors. Alternating current is reported to be less satisfactory for haulage than direct, but by using an A. C. locomotive a converter is dispensed with.

TABLE 17. *Preparation of coal for market*

Mine no.	Material of tipple	Shaker screen: Length in feet	Shaker screen: Width in feet	Shaker screen: Inclination: inches per foot	Shaker screen: Shakes per minute	Is coal rescreened or washed?	Per cent of total output: Over 1½ inches	Per cent of total output: Over 6 inches
25	Steel	25	6	1	70	Rescreened	68	
26	Steel	37½	8	1	80	Neither	70	35
27	Steel	32	8	1	78	Neither	70	32
28	Wood		12	1	82	Rescreened	75	32
29	Wood	75		1	70	.	71	72
31	Wood	31	7	3	80	Neither	67	20
32	Wood	30	6	1	80	Neither	68	20
33	Wood	68	8	3	78	Rescreened	75	50
34	Wood	30	5½	4	70	....	67	25
35	Wood	30	6	3	80	Neither		..
36	Wood		12	.	80	Neither	67	33
37	Wood	55	12	3	80	Neither	65	30
38	Wood	38	6	4	70	Neither	....	..
39	Steel	45	15	3	80	Neither	70	32
40	Wood	40	4	3	80	Neither	71	33
41	Wood		6	..	75	Rescreened	70	...
42	Wood	..	7		...	Rescreened	*	.

*68 per cent over 2 by 2½ inch holes.

Steel tipples have been built at four of the mines examined. Fig. 23 shows a typical surface plant in the district. Automatic recording track scales have been placed at several plants and at one pit cars are weighed on automatic scales which weigh each car and print the weight automatically.

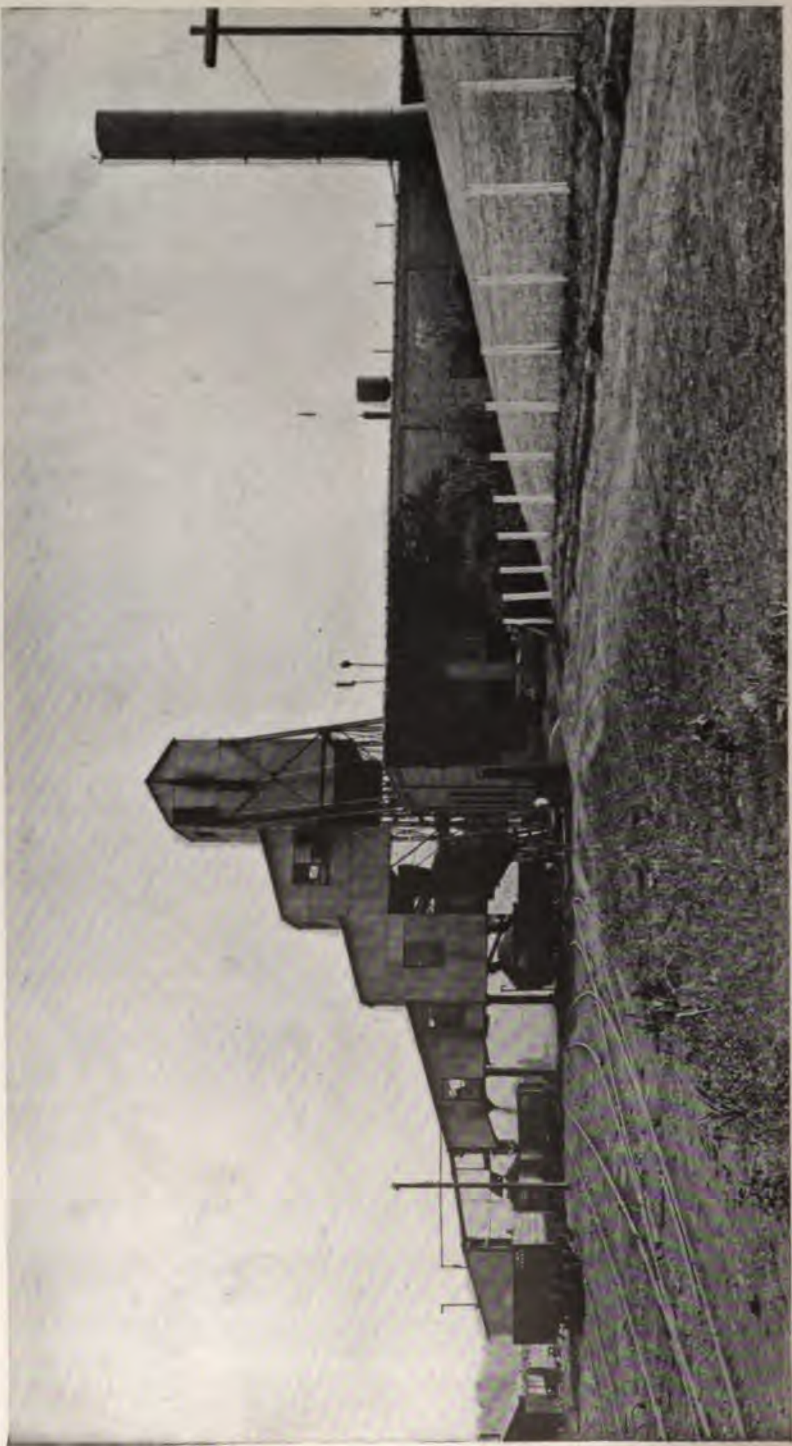


Fig. 23. Typical surface plant at shipping mine (Photo loaned by Mr. F. S. Peabody)

In a few instances where platform cages are used cars are pushed by hand on to a revolving cradle and dumped. Box car loaders are found at several mines.

The surface overlying the workings is owned by the operators at some mines and at one it is farmed, and corn is raised for 36 mules.

Table 18 gives surface plant equipment.

TABLE 18.—*Surface plant equipment*

Mine no.	No. loading tracks beneath tipple	No. cars stored above tipple	Boilers			Electric generators	
			No.	Total H. P.	Av. steam pressure	K. W.	Volts
25	2	40	5	700	90	200	250
26	3	30	0	...	.....	150	250
27	4	40	3	700	70	100	250
28	4	40	3	225	100	150	250
29	4	23	2	250	100	100	250
31	4	45	6	875	90	300	250
32	4	25	3	250	90	100	250
33	2	50	6	750	105	150	250
34	3	35	2	250	95	50	125
35	3	20	3	175	80	100	225
36	3	55	5	700	90	..	...
37	4	120	5	750	90	200	250
38	3	50	4	600	100	150	250
39	4	100	4	600	115	45	125
40	4	25	3	185	80	100	250
41	2	20	4	280	80	50	150
42	2	18	4	350	110	8	110

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Bulletin 1. Preliminary Report on Organization and Method of Investigations, 1913. (Out of print.)

Bulletin 2. Coal Mining Practice in District VIII (Danville), by S. O. Andros, 1914.

Bulletin 3. A Chemical Study of Illinois Coals, by Prof. S. W. Parr. (In press.)

Bulletin 4. Coal Mining Practice in District VII (Mines in bed 6 in Bond, Clinton, Christian, Macoupin, Madison, Marion, Montgomery, Moultrie, Perry, Randolph, St. Clair, Sangamon, Shelby, and Washington counties), by S. O. Andros, 1914.

Bulletin 5. Coal Mining Practice in District I (Longwall), by S. O. Andros, 1914. (Out of print.)

Bulletin 6. Coal Mining Practice in District V (Mines in bed 5 in Saline and Gallatin counties), by S. O. Andros, 1914.

Bulletin 7. Coal Mining Practice in District II (Mines in bed 2 in Jackson County), by S. O. Andros, 1914.

Bulletin 8. Coal Mining Practice in District VI (Mines in bed 6 in Franklin, Jackson, Perry, and Williamson counties), by S. O. Andros, 1914.

Bulletin 9. Coal Mining Practice in District III (Mines in beds 1 and 2 in Brown, Calhoun, Cass, Fulton, Greene, Hancock, Henry, Jersey, Knox, McDonough, Mercer, Morgan, Rock Island, Schuyler, Scott, and Warren counties), by S. O. Andros, 1915.

Bulletin 10. Coal Resources of District I (Longwall), by G. H. Cady, 1915.

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Bulletin 12. Coal Mining Practice in District IV (Mines in bed 5 in Cass, DeWitt, Fulton, Knox, Logan, Macon, Mason, McLean, Menard, Peoria, Sangamon, Schuyler, Tazewell, and Woodford counties), by S. O. Andros, 1915.

*Bulletin 72. U. S. Bureau of Mines, Occurrence of Explosive Gases in Coal Mines, by N. H. Darton, 1915.

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*Copies of this bulletin may be obtained by addressing the Director, U. S. Bureau of Mines, Washington, D. C.